Achieve for Calculus Efficacy Brief

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Forward

At Macmillan Learning we are committed to developing learning solutions that help Calculus instructors and their students to achieve their full potential. We go about this by co-designing with students, collaborating with leading educators and learning scientists, and partnering with colleges and instructors to research effectiveness and efficacy and share insights for success. Our goal is to help advance teaching and learning by enabling evidence-based decision making and to contribute to research into educational technology. To these ends, we take a comprehensive approach to measuring the effectiveness and efficacy of the digital learning tools that we produce. This report represents one study that makes up the larger body of efficacy research into Achieve.

We thank the incredible Calculus instructors and their students who partnered with us on this research:

Marwan Abu-Sawwa Florida State College at Jacksonville
Shaun Ault Valdosta State University
Ashley Boone Pellissippi State Community College
Williams Griffiths Kennesaw State
Kiandra Johnson Spelman College
Jonathan Lamb Pellissippi State Community College
Val Mohanakumar Hillsborough Community College – Dale Mabry
Ruth Trubnik Delaware Valley College
A professor at Drexel University

Research Ethics This research complied with APA ethical standards for research. It was approved by a third-party Institutional Review Board (IRB) prior to participant recruitment, and further approved by individual institutional IRBs at each participating college, where required.
Introduction

In 2017 the Mathematics Association of America reported that the national average of unsuccessful Calculus 1 students was 25%. A quarter of undergraduate students failing to succeed in their Calculus I courses is not only detrimental to the failing students — requiring more time in college, likely incurring more debt — but it negatively impacts society at large. Calculus 1 has the unique position of a gateway course to most science, technology, engineering, and mathematics (STEM) degrees. In fact, almost all STEM majors need to take at least the first course in a traditional Calculus sequence. And, given that careers requiring STEM degrees are on the rise, the lack of a skilled workforce to fill those positions weakens the United States workforce and threatens its position in the global economy. Instructors are working to identify resources and best practices that will complement their pedagogy, get and keep their students engaged, and challenge their most academically prepared students while helping to fill the skills gaps of their less academically prepared students.

Achieve, a new next generation learning solution has been designed and developed to help instructors meet those goals. With a powerful Math Assessment Engine, SymPy, Math Palette, Guided Learn and Practice assignments, & Dynamic figures powered by Desmos, we are helping teach students conceptual understanding and critical thinking in real-world contexts.

To provide instructors evidence of Achieve’s effectiveness and practical insights on how to amplify those effects, we took the unusual step of beginning to evaluate Achieve while it was still in testing. This way, we could provide instructors with timely information they could use to make adoption and implementation decisions and not risk false starts or frustrations with a new tool.

In the Fall 2019 semester, nine Calculus instructors partnered with Macmillan Learning to better understand whether Achieve would support student success in their courses. This research brief outlines those partnerships and highlights the results of the study. The report begins with an overview of the Achieve platform and a description of Achieve for Calculus, the research procedures including samples and methods are presented next, followed by results and implications for instructors.
Achieve

Achieve for Calculus

Achieve, a new next generation learning solution has been designed and developed to help instructors meet their goals. Through the Math Assessment Engine, which combines our proprietary parser and the computer algebra system, SymPy, allowing us to accept every valid equivalent answer, the easy-to-use Math Palette, targeted feedback, Guided Learn and Practice assignments, & Dynamic figures powered by Desmos, we are helping teach students conceptual understanding and critical thinking in real-world contexts.

Research Procedures

This research complied with American Psychological Association ethical standards for research. It was approved by a third-party Institutional Review Board (IRB) prior to participant recruitment, and then approved by instructor participant’s individual institutional IRBs where required.

In the Fall 2019 semester nine Calculus instructors agreed to participate in an evaluation of Achieve before it was to be used at scale. Prior to the start of the semester, Instructors completed a thirty-minute training on how to use Achieve. During training instructors were offered suggestions for best-practice implementations based on learning science research. However, specific implementations were not mandated as part of the evaluation. The only requirement was that Achieve be the primary curricular material used that semester.

Achieve is a next-generation digital learning solution developed for higher-education courses that provides a connected suite of course content and tools. It was designed to give instructors choice, with flexible recommendations for optimal pedagogical structures based on the learning sciences.

Achieve was developed based on three foundations of learning science

1. Effective learning objectives. Effective learning objectives enable instructional alignment across all instructional and assessment content/components via backward design.

2. Impactful assessment practice. Research shows that an evidence-based, learning-objective-driven assessment strategy addressing cognitive and noncognitive aspects of the learning experience can drive better learner engagement, motivation, self-regulation, and performance.

3. Empowering analytics for instructors and students. The analytics provided to instructors in Achieve provide timely and actionable insights to support teaching and learning.
Data Collection and Research Questions

Data were collected for a mixed-methods analysis. Students and instructors completed surveys at the beginning and end of the semester, instructors completed weekly implementation logs, and instructor interviews were conducted mid-semester. Product usage data were extracted from the Achieve platform on a weekly basis and at the end of study, and student course records (for consenting students) — quiz, test, exam grades, attendance records — were shared by instructors at the end of the semester. Data were matched across sources, and descriptive and empirical analyses were conducted [for a full description of data collection see Achieve More: the learning engineering of Achieve and insights into instructor implementations and instructor and student outcomes].

This study addressed three research questions designed to help Calculus educators better understand whether Achieve for Calculus would be an effective solution in their educational context and how they might implement it to best effect.

1. How are Calculus instructors using Achieve and how are students engaging with it?
2. What are Calculus student and instructor perceptions of Achieve?
3. Does use of Achieve for Calculus influence final-exam scores after accounting for their high school grade point average?

Achieve was conceived based on six learning design principles.

1. Develop Learner Motivation. When students are highly motivated, they are able to tackle challenging problems and strive to accomplish goals that will improve their abilities.

2. Provide Personalized and Adaptive Experiences. Students enter the classroom with a variety of cultures and psychological traits, thus, personalization and adaptation of instruction and assessment can have positive effects for all learners.

3. Target Cognitive and Memory Elements. Today, there are numerous methods that learning scientists have researched to enhance learner cognition and transfer. These begin with learning objectives, which describe “the intended change in knowledge” and can enable a mastery approach which has positive impacts on conceptual learning, attitudes toward learning, and performance.

4. Build on Well-Constructed Learning Models. Being cognitively engaged stimulates learning, specifically, learning that “sticks”. Active learning, which can be fostered through models including Project-Based Learning (PjBL) and Problem-Based Learning (PBL), lead to the growth of complex-reasoning skills, critical-thinking processes, perceived learning, engagement, attitudes towards and perceived usefulness of subjects, self-directed learning, exam performance, motivation, and autonomy.

5. Create Interactive and Constructive Opportunities. The development of critical-thinking skills and higher-order learning benefit from collaborative learning, which lead to enhancement in academic performance and intellectual development.

Sample Description

In total, nine Calculus I instructors across eight institutions partnered with researchers at Macmillan Learning to evaluate the effectiveness of Achieve for Calculus. The institutions included Pellissippi State Community College, Valdosta State University, Delaware Valley College, Drexel University, Florida State College at Jacksonville, Hillsborough Community College, Spelman College, and Kennesaw State University. The majority (75%) are two-year institutions and 60% are public.

The background and experiences of the instructors in this sample varied. Half had been teaching Calculus between 11 and 15 years and half had been teaching for more than 15 years. In total, half reported being "comfortable" with technology, 25% were "somewhat comfortable" and 25% were "very comfortable". Half strongly agreed that digital learning tools had the potential to enhance student learning. Most (87.5%) had used digital learning tools during the last semester that they taught this course.

In total, 367 students consented to participate in this study [76% of the population of students enrolled across the 9 participating courses]. The largest proportion (48%) were first year students, the majority (56%) identified as male, most (70%) were eligible for federally funded financial aid, 22.1% identified as being part of a traditionally underrepresented racial/ethnic group, and 22% reported being the first person in their family to attend higher education [first generation student]. Most students were classified as "college ready" (as measured by meeting or exceeding the college readiness benchmark on either the SAT or ACT). The majority of students had used a publisher provided digital learning tool in a classroom previously (86%) and either agreed or strongly agreed that it had enhanced their learning (82%). Most students were taking this course as part of a major credit requirement (71%), 22% were taking it as a general credit requirement, and 7% were taking it as an elective.

RESULTS

RESEARCH QUESTION 1

Results

Research Question 1.

How are Calculus instructors using Achieve and how are students engaging with it?

We hypothesized that instructors would implement Achieve regularly throughout the semester. Because of the robustness of the program, we further hypothesized that instructors would assign activities from Achieve to be completed before and after the class where the content would be lectured on. Since Achieve offers instructors analytic reports of student engagement and performance, we expected that they would use those insights to adapt or focus their in-class lectures and/or planned activities. Among students, we hypothesized that they would use Achieve at a high rate because of its engaging features, the wealth of feedback they receive, and because prior research conducted by the authors suggested that students had positive perceptions of Achieve and believed that it supported their academic performance in Calculus. We did not hypothesize about implementation or engagement by educational context as we had no prior research to base a theory, so those analyses are meant as exploratory.

Achieve platform data were analyzed to investigate usage. Calculus instructors in the sample assigned an average of 68.88 (SD = 41.90) assignments in Achieve over the course of the semester, with the proportion of assignments ranging from 12 to 115 across instructor. It is important to consider that readings are assigned in chunks (or “snippets”) for consumability, so assignment of eBook snippets inflates the average assignment rate. When calculated without considering eBook snippets, on average, Calculus instructors...
assigned 51.0 activities [range 10 to 77]. On average, instructors assigned Achieve activities in 92% of the weeks in the semester, and reported that the only times they did not assign Achieve were weeks in which classes were not held. There was a statistically significantly positive relationship between the number of activities an instructor assigned and their course final exam score average \( r^2 = .36, p = 0.035 \) and their course average final grade \( r^2 = .21, p = 0.040 \), suggesting that the more assignments assigned, the better they could expect their students to perform in the course.

**TABLE 1. Empirical Implementation Patterns**

Empirical implementation patterns matched to instructor survey and interview data were used to establish use cases. Activities were classified as either (1) reading (2) diagnostic (3) pre-class formative assessment, (4) in-class activity, (5) post-class formative assessment or (6) post-class summative assessment.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>Any reading “snippet” assigned</td>
</tr>
<tr>
<td>Pre-class formative assessment</td>
<td>Any assessment where students were given more than one opportunity to answer a question correctly or where the goal was persistence to completion and when the assignment was due prior to the class in which the content would be introduced. These activities tended to be video tutorials and LearningCurve activities.</td>
</tr>
<tr>
<td>In-class activity</td>
<td>Any activity that was assigned to be completed during in-class time. These activities tended to be case studies, current event assignments, and iClicker student response system questions.</td>
</tr>
<tr>
<td>Post-class formative assessment</td>
<td>Any assignment where students were given more than one opportunity to answer a question correctly or where the goal was persistence to completion and when the assignment was due after the class in which the content was introduced. These activities tended to be end of chapter problems, data analysis activities, etc.</td>
</tr>
<tr>
<td>Post-class summative assessment</td>
<td>Any assignment where students were given one attempt to answer a question correctly and there were a discrete number of items presented to a student, or the activity was weighted more heavily in a student’s grade. These activities tended to be quizzes, tests, and homework.</td>
</tr>
</tbody>
</table>
TABLE 2. Empirical implementation patterns in this sample

An algorithm was developed to classify overall implementation patterns. The proportion of weeks in their semester that each instructor assigned a specific asset type was calculated and an instructor was coded as a type of activity assigner. An instructor was considered an activity assigner if the activity type was assigned to be due in at least 10% of the active weeks (not including break) during their semester. Five empirical implementation patterns emerged and were validated qualitatively.

<table>
<thead>
<tr>
<th>INSTRUCTOR(S)</th>
<th>IMPLEMENTATION MODEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor 1, 2, 3, 4</td>
<td>Summative assessments only</td>
</tr>
<tr>
<td>Instructor 5</td>
<td>Pre-class formative and summative assessments</td>
</tr>
<tr>
<td>Instructor 6</td>
<td>Pre-class formative, post-class formative, and summative assessments</td>
</tr>
<tr>
<td>Instructors 7, 8</td>
<td>Pre-class formative, in-class, and summative assessments</td>
</tr>
<tr>
<td>Instructor 9</td>
<td>In-class and summative assessments</td>
</tr>
</tbody>
</table>

Interestingly, 45% of instructors used Achieve for Calculus as a summative assessment tool only, but 45% did use the tool as a pre-class and post-class solution, as we had hypothesized. On average, performance in Achieve accounted for 31% of a student’s final course grade (SD=7.4). Implementation patterns and grading policies did not vary meaningfully across educational contexts.

Instructors were presented with data analytics that provided insights in reports at the course, unit, and learning objective level. The majority of instructors in this sample (n=7, 78%) accessed the reports in Achieve in at least 85% of the active weeks of their semester. Each week instructors were asked in their implementation logs whether they took action based on the insights provided in the reports and all indicated that they had. The primary action that instructors

Achieve’s instructor dashboard allowed me to adapt my teaching style to students’ results—to make my teaching more interactive.

—Ruth Trubnik
Delaware Valley University
reported taking (71%) were modifying their class lecture based on what students were struggling with or what they had already mastered. A smaller proportion, but most (57%) reported intervening with specific students based on the student-level insights provided. Instructors had positive perceptions of the analytic dashboards, as shown in Figure 1.

**STUDENT ENGAGEMENT**

Platform analytics were used to calculate student usage rates. Average total usage was calculated by dividing the total number of activities launched over the total number of activities assigned. They average overall total usage rate was 60.92%. Individual student usage rates ranged from 2.2% to 100%. Figure 2 presents the student usage rates overall and by activity type.
What was surprising (to me) was the constant way that Achieve promoted student collaboration. I don’t know if that was an intended feature, but somehow we’ve formed a very interactive classroom community here.

— Bill Griffiths
Kennesaw State University

Instructors and students were also asked to report how engaged they perceived students/themselves to be the semester they were using Achieve, and how typical they found that level of engagement to be. Instructors reported that, on average, the majority of students in their classes (69%) were actively engaged during most class meetings. A quarter of instructors reported that this level of engagement was more engaged than students typically are in this course and 38% of students reported being more engaged than they typically were in their other courses that semester. Responses are presented in Figure 3.
**Figure 3.** Instructor and student perceptions of student engagement inside and outside of class time

- **Instructors**
  - Engagement in class discussion: 37.5%, 25%, 25%
  - Engagement in content outside of class: 62.5%, 25%

- **Students**
  - Engagement in class discussion: 38.4%, 22%, 5.5%
  - Engagement in content outside of class: 53%, 21%, 21%

- Color coding:
  - Very Disengaged
  - Disengaged
  - Moderately engaged
  - Engaged
  - Very Engaged
Research Question 2.
What are instructor and student perceptions of Achieve?

INSTRUCTOR PERCEPTIONS
Instructors in this sample had high perceptions of Achieve, they were asked to rate their level of agreement with a set of statements between strongly disagree = 1, disagree = 2, agree = 3, and strongly agree = 4. Figure 4 presents the average ratings.

![Figure 4. Instructor general perceptions of Achieve](image)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Average Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achieve was easy to set up and use</td>
<td>3.38</td>
</tr>
<tr>
<td>Achieve offered analytics to support instruction</td>
<td>3.00</td>
</tr>
<tr>
<td>Achieve helped me understand student content gaps</td>
<td>3.00</td>
</tr>
<tr>
<td>Achieve enhanced my pedagogy</td>
<td>2.87</td>
</tr>
<tr>
<td>Achieve saved me time in the classroom</td>
<td>2.87</td>
</tr>
<tr>
<td>Achieve is flexible enough to meet my needs</td>
<td>2.87</td>
</tr>
</tbody>
</table>

**SCALE:** 1 = STRONGLY DISAGREE  2 = DISAGREE  3 = AGREE  4 = STRONGLY AGREE
Calculus instructors were also asked to rate (on the same scale) their perception of resource organization and value. Instructors had similarly high ratings of these statements.

![Figure 5. Instructor perceptions of resource organization and value](image)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>It was clear how to set up a chapter in Achieve</td>
<td>3.50</td>
</tr>
<tr>
<td>The order of resources aligned to my pedagogical</td>
<td>3.50</td>
</tr>
<tr>
<td>I understood what each of the resource names meant</td>
<td>3.25</td>
</tr>
<tr>
<td>I could efficiently navigate through resources</td>
<td>3.25</td>
</tr>
<tr>
<td>It was obvious how resources related to one another</td>
<td>3.00</td>
</tr>
<tr>
<td>Searching for resources was easy</td>
<td>3.00</td>
</tr>
</tbody>
</table>

**SCALE:** 1 = STRONGLY DISAGREE      2 = DISAGREE      3 = AGREE       4 = STRONGLY AGREE

Instructors were asked to report the extent to which they agreed that Achieve enhanced learning in their course and the extent to which they agreed that Achieve supported student mastery [scale 1-4] and the average rating of both was 3.25. When asked to rate their perception of individual Achieve assets that they implemented ratings were high as well.

**Pre-lecture activities.** Among Calculus instructors who assigned pre-class activities, 100% agreed or strongly agreed that they helped communicate what would be covered in the next class meeting; 88% agreed or strongly agreed that they helped fill skills gaps, increased participation in class, and fostered active learning, and 80% agreed or strongly agreed that pre-class activities fostered a basic understanding of the content.
**Post-lecture activities.** Among Calculus instructors who assigned post-class activities, 90% agreed or strongly agreed that they reinforced course concepts, and 80% agreed or strongly agreed they were engaging for students, 60% reported that they kept students on track and that they supported participation in class.

**CURBING INSTRUCTOR DIFFICULTIES**

At the beginning of the semester we asked instructors to rate, on a scale of 1 = “very difficult”, 2 = “difficult”, 3 = “easy”, 4 = “very easy” how difficult a set of activities were in their course the last time that they taught it. At the end of the semester we asked instructors to rate, on the same scale, how difficult the same set of activities were in their course this semester. Figure 6 presents the average ratings on the pre-survey and the average rating on the post-survey for each statement. Instructors rated each statement easier, on average, after using Achieve than they had on the pre survey with the exception of “implementing active learning” which was rated slightly less easy on the post-survey.

The resources in Achieve allowed students to come to class are prepared which enabled us time to incorporate clicker quizzes during class. I would often poll the students and then allow them time to discuss with a partner if the individual results were not favorable.

—Kianda Johnson

Spelman College
FIGURE 6. Instructor ratings of difficulty on the pre- and post-survey

- Difficulty fostering deep insights: 2.37 (Before using Achieve), 2.75 (With using Achieve)
- Difficulty fostering curiosity: 2.75 (Before using Achieve), 2.88 (With using Achieve)
- Difficulty implementing active learning: 2.75 (Before using Achieve), 3.25 (With using Achieve)
- Difficulty promoting student collaboration: 2.38 (Before using Achieve), 2.75 (With using Achieve)
- Difficulty promoting student comprehension: 2.88 (Before using Achieve), 3.13 (With using Achieve)

SCALE: 1 = VERY DIFFICULT, 2 = DIFFICULT, 3 = EASY, 4 = VERY EASY
STUDENT PERCEPTIONS

Students were asked to rate, on a scale of 0 to ten how likely they were to recommend this course to a friend if they knew that Achieve would be used again. Graph 1 presents the distribution of student responses. The average response among students was 6.74.

GRAPH 1. Distribution of student rating of likelihood to recommend course to a friend if Achieve is being used   Note: n=256
Students were also asked to report on the usability of various aspects of Achieve by rating a set of items using the scale 1 = strongly disagree, 2 = disagree, 3 = agree, or 4 = strongly agree. The statements were; “I had no problem accessing Achieve”, “Achieve is easy to navigate”, and “It was clear when activities were due”. Figure 7 presents the average student ratings.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>I had no problem accessing Achieve</td>
<td>2.91</td>
</tr>
<tr>
<td>Achieve is easy to navigate</td>
<td>2.97</td>
</tr>
<tr>
<td>It was clear when activities were due</td>
<td>3.12</td>
</tr>
</tbody>
</table>

When asked to rate, overall, how strongly students agreed that Achieve helped them gain better mastery of the course content than a course without Achieve, 74% of Calculus students either agreed or strongly agreed with this statement. Like instructors, Johnathon Lamb’s Calculus I class
students were also asked to rate their perception of individual assessment types. Students were asked to rate, on the same four-point strongly disagree to strongly agree scale the extent to which they agreed with statements about pre-lecture activities [if they were assigned them] and post-lecture activities [if they were assigned them]. Figures 8 and 9 present the results of those questions.

**Figure 8.** Average student perceptions of Achieve for Calculus pre-lecture activities

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helped me understand what we would be covering in</td>
<td>2.77</td>
</tr>
<tr>
<td>Helped me achieve a basic understanding of concepts with my</td>
<td>2.86</td>
</tr>
<tr>
<td>Helped me stay on track during class discussion</td>
<td>2.80</td>
</tr>
<tr>
<td>Helped me participate more in class than they</td>
<td>2.56</td>
</tr>
<tr>
<td>Helped me actively learn in my class</td>
<td>2.74</td>
</tr>
</tbody>
</table>

**SCALE:** 1 = STRONGLY DISAGREE    2 = DISAGREE    3 = AGREE    4 = STRONGLY AGREE
Figure 9. Average student perception of post-lecture activities

<table>
<thead>
<tr>
<th>Perception</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Were the appropriate length for the topic</td>
<td>2.77</td>
</tr>
<tr>
<td>Were the appropriately challenging for me</td>
<td>2.86</td>
</tr>
<tr>
<td>Helped fill my information gaps</td>
<td>2.79</td>
</tr>
<tr>
<td>Helped foster deeper insights about the content</td>
<td>2.78</td>
</tr>
<tr>
<td>Helped me stay on track during class discussion</td>
<td>2.61</td>
</tr>
<tr>
<td>Were engaging</td>
<td>2.77</td>
</tr>
<tr>
<td>Helped me participate more in class than I typically do</td>
<td>2.81</td>
</tr>
</tbody>
</table>

**Scale:** 1 = Strongly Disagree  2 = Disagree  3 = Agree  4 = Strongly Agree
RESULTS

RESEARCH QUESTION 3

Research Question 3.
Is the use of Achieve related to academic performance in the course for less and more prepared students?

Research presented from a study conducted during the Spring 2019 semester demonstrated a statistically significantly positive relationship between use of Achieve and final exam scores in Calculus courses. The study also found that the magnitude of the difference was even stronger among students who fell below the average high school grade point average (HSGPA) in the sample \( r(81) = .51, p<.0001 \) among less academically prepared students compared to \( r(113) = .40, p<.0001 \) among more academically prepared students. We wanted to investigate whether we could replicate those findings with a more generalizable set of students this semester.

Like the Spring study, the Fall 2019 data were disaggregated by whether a student fell above or below the mean HSGPA (Mean = 3.65, SD=0.55) and students were split into three engagement bands based on their total rate of engagement in assigned activities in Achieve (<40% engagement, 40%-79% engagement, 80%+ engagement). PROC GLM in SAS was used to calculate a one-way ANCOVA and determine whether there was a statistically significant difference in average final exam scores based on a student’s level of engagement in Achieve for Calculus controlling for HSGPA. There is a significant effect of engagement on final exam score after controlling for HSGPA, \( F(3,252) = 2.66, p=0.034 \).

To visualize the relationship, Figure 10 presents the average exam score by engagement band, by level of academic preparedness coming into college as measured by HSGPA.

Implications for instructors:

1. Assign Achieve activities regularly throughout the semester, student engagement rates are high and help students participate more in class.
2. Assign Achieve activities before and after the class lecture on aligned content to prepare students to participate and reinforce learning.
3. Utilize the Achieve insights dashboards in the hours before class to evaluate what students already comprehend and help focus your class time on where they have gaps.
4. Monitor the engagement of students less academically prepared and prompt them to keep up — because research shows more engagement will get them on track.
5. Encourage students to retake Learning Curve activities before in-class assessments, students say that doing so helped boost their exam grades.
As Figure 10 demonstrates, there is a positive relationship between use of Achieve and final exam score among more and less academically prepared students. The figure also shows that less academically prepared students can expect an average 10 percentage points higher on their final exam score if they engage in at least 80% of the activities their instructor assigns in Achieve for Calculus. And, that the gap in performance between less academically prepared students and their more prepared peers closes from 15 percentage points to about 6 percentage points when they complete at least 80% of their assigned activities.
DISCUSSION AND CONCLUSION

Discussion

The results from this study suggest that Achieve for Calculus is flexible and instructors are able to implement it effectively in a way that best compliments their pedagogy. And, that instructors and students have high perceptions of the tool. Most importantly, the findings suggest that use of Achieve influences stronger performance on final exams regardless of a student’s level of academic preparedness coming into the course. And, that more use of Achieve for Calculus may close the skills gap between students less academically prepared to succeed and their more academically prepared peers.

Our findings suggest that less academically prepared students who engage in at least 80% of their assigned activities can move from a failing grade to a passing grade at most US colleges. With an average of 25% of students failing to succeed in Calculus I courses, in addition to finding this difference statistically significant, many educators may find this difference educationally significant.

Conclusion

Macmillan Learning took the unusual approach of beginning to collect evidence of effectiveness and efficacy during Achieve’s development. These results were used for both the evolution and optimization of Achieve for Calculus and so that instructors could have timely insights that were relevant to them before they made adoption and implementation decisions. The findings from this study are promising and suggest that Achieve for Calculus can help all students succeed, but should be interpreted as results from an early beta product. The authors look forward to building on this evidence in the studies to come.
Limitations and future research

The results in this study are very promising and contribute sound evidence to the efficacy argument of Achieve, but like all applied research there are important limitations to discuss. Most important to note is that the design and analyses presented in this study are descriptive and correlational and therefore causal statements cannot be made based on the results. Although we controlled for student prior academic performance when measuring the relationship with final exam scores, there are a myriad of other factors that could be contributing to the outcomes measured. A quasi-experimental study that will build on these results and the results from the replication study is currently underway. The results from the analyses conducted during that study will enable causal statements of efficacy.

Note on data privacy

Prior to data collection, this study and the associated consent forms and instruments were reviewed and approved [found exempt] by the Human Resources Research Organization (HumRRO). HumRRO is a third-party Institutional Review Board organization with no affiliation with Macmillan Learning [federal wide assurance number 00009492 and IRB number 00000257]. Macmillan Learning seeks independent and unfunded third-party review to eliminate any bias in decision of exemption. Macmillan Learning then seeks local Institutional Review Board approval at each participating institution, where required. The data collected in this study, which are provided by the instructor and consenting students, are initially identifiable. However, once a random identifier is generated identifiable data are destroyed. Data are provided in secure storage locations, and access is permitted only to the primary investigator in the study. For full details of our data handling and storage privacy procedures, contact Kara McWilliams, Vice President Impact Research at Macmillan Learning at kara.mcwilliams@macmillan.com.
About Macmillan Learning

Macmillan Learning improves lives through learning. Our legacy of excellence in education continues to inform our approach to developing world-class content with pioneering, interactive tools. Through deep partnership with the world’s best researchers, educators, administrators, and developers, we facilitate teaching and learning opportunities that spark student engagement and improve outcomes. We provide educators with tailored solutions designed to inspire curiosity and measure progress. Our commitment to teaching and discovery upholds our mission to improve lives through learning. To learn more, please visit http://www.macmillanlearning.com or see us on Facebook, Twitter, LinkedIn or join our Macmillan Community.

About the Learning Science and Insights Team

As the Learning Insights company, we are passionate and scientific about helping students, instructors, and institutions to achieve their full potential. We use a unique combination of user-centered design, research from the learning sciences, and empirical insights from extensive data mining and Impact Research. To learn more about this approach, please visit http://www.macmillanlearning.com/catalog/page/learningscience
To obtain instructor access to Achieve for Calculus or to sign up for a demo, visit the Macmillan Learning Catalog.
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