9/30/2019

Bossier Parish Community College First in the World Evaluation: Final Annual Performance Report

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This work has been supported by the U.S. Department of Education's Fund for the Improvement of Postsecondary Education (FIPSE) First in the World (FITW) program, through Grant #P116F150084. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

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Background

In 2015, Bossier Parish Community College (BPCC), located near Shreveport in northwest Louisiana, received a four-year grant through the United States Department of Education's (US DOE) First in the World (FITW) grant program.

As set forth in its FITW grant application, BPCC's initiative consists of two interrelated strategies:

1) strengthen student learning through gamification of a native, untethered, mobile learning application for developmental education courses, and
2) integrate the learning application into an integrated data platform (IDP) of campus data streams, creating a predictive flow model illuminating patterns of student persistence and learning.

BPCC's approach of creating mobile applications for one English (English 99) and two math (Math 98 and Math 99) developmental education courses builds on its prior efforts designing *Open Campus*™,[1] a free online platform that provides access to developmental education course content to students anywhere in the world.

BPCC's goal is to improve the academic performance of students enrolling in developmental education courses, increase these students' rates of persistence and degree attainment, and develop methods rooted in data science for predicting the success of developmental education students and intervening with students predicted to have low odds of success.

This Evaluation

All FITW grants require an evaluation to be conducted by an independent third-party evaluator. BPCC's evaluation is being conducted by Giani Consulting & Evaluation, LLC. The evaluation consists of

- an **impact evaluation** using a randomized controlled trial (RCT) design to produce unbiased estimates of the effect of the intervention on student outcomes, and
- an **implementation evaluation** that seeks to explore the extent to which BPCC implemented with fidelity the activities included in its grant application—as well as the factors that were most influential in facilitating or obstructing implementation.

The impact evaluation focuses exclusively on the impact of the mobile apps on student performance, whereas the implementation evaluation examines the implementation of both the mobile apps and the integrated data platform.

For the impact evaluation, BPCC provided the evaluator with data on all courses that students in the analytic sample attempted prior to and through the Spring 2019 semester, including course credit and grade information, credentials earned by students through that semester, and data on students' background characteristics. This data was used to assess the impact of access to the mobile apps on students' course performance - as indicated by course pass rates, grades in the developmental education courses, semester GPA, and persistence into the next semester – and the attainment of credentials.

[1] For more on BPCC's *Open Campus*™, see http://www.bpcc.edu/opencampus.

The evaluator collected data for the implementation evaluation through a variety of methods, including

- annual site visits to interview students, faculty, and staff at BPCC to understand how implementation was proceeding,
- surveys administered to various stakeholders to gauge responses to the intervention, and
- regular phone calls with FITW staff at BPCC to assess progress toward goals and activities outlined in BPCC's logic model for this project (see Table 1: Logic Model for BPCC's FITW Initiative).

This final Annual Performance Report is designed to

- document the fidelity of implementation and assess factors influencing implementation through the final year of the grant period (2018–2019),
- summarize the results of the impact evaluation for both the first (Spring 2017) and second (Fall 2017) cohorts,
- estimate the impact of access to the mobile apps on students' credential attainment rates through Spring 2019.

The rest of this executive summary overviews key findings from this final annual performance report.

Summary of Year 4 Findings

1. A Beta Version of the Mobile Apps was Piloted with Two Cohorts, and a Fully Functioning Version of the Mobile Apps was Released in 2018-19.

BPCC piloted the Phase 1 mobile apps with two cohorts of students. Cohort 1 received access to the apps in Spring 2017, and Cohort 2 received access in Fall 2017. Both cohorts used a beta version of the apps that are more accurately described as mobile-responsive versions of the Open Campus website that students were instructed to save as an icon on the home screen of their smartphone, rather than native mobile apps. Both cohorts were randomly assigned to receive access to the mobile apps or not by randomly assigning course sections to treatment and control conditions.

In the final year of the grant, BPCC released fully functioning versions of the mobile apps that are available for download through the Apple App Store and Google Play. The apps now provide a more seamless user experience and additional functionality including auto-grading of quizzes and assignments, a gradebook, better integration of analytics functionality, greater accessibility (that is, compliance with the Americans with Disabilities Act), enhanced administrator/faculty tracking of student engagement, and compatibility with iOS and Android, among other updates.

2. The Integrated Data Platform (IDP) Has Seen Widespread Use Among BPCC Advisors, but Less Use Among Faculty.

BPCC entered the third year of implementation of its integrated data platform, Civitas Learning's[2] Inspire platform. This tool enables faculty and front-line staff to access in a single location various data related to students' backgrounds, target intervention and outreach efforts toward students identified as

[2] Civitas Learning, Inc., provides resources to higher education that help bring together diverse sources of data; for more information, see https://www.civitaslearning.com/about.

being at-risk of dropping out, and document these interventions so that other stakeholders are aware of the efforts that have been taken to support students.

During 2017–2018, more than 150 BPCC staff received training on Inspire through a total of 16 workshops. The staff served constitute more than 75 percent of the BPCC personnel who advise students. Inspire was used to make more than 10,000 outreaches to students during that academic year. The IDP has been integrated into the workflow of BPCC advisors, but a minority of faculty are regularly using the platform.

3. Faculty Remain Engaged with the FITW Initiative, but Contextual Factors Impede Implementation.

The majority of instructors interviewed supported the developmental education mobile apps and acknowledged the benefits of the IDP. However, contextual factors impede implementation. Two factors in particular have posed the greatest challenge.

First, instructors felt that limitations of the Phase 1 mobile apps hindered their utility. For example, the mobile apps were not available through common mobile app repositories such as the App Store and Google Play, and instructors could not log into the apps and see how their students were using them. The Phase 2 mobile apps have addressed many of the issues raised by faculty, but incorporation of the mobile apps into course expectations, assignments, and instruction is uneven. However, the vast majority of instructors support the mobile apps and recommend them to students, even if instructors do not integrate the apps into their courses.

Second, instructors' perceptions of the IDP were colored by their dissatisfaction with advising students. Although student advising is a required part of faculty work per BPCC faculty contracts, the majority of instructors felt they were not sufficiently compensated or trained for this work. Faculty buy-in for the IDP will likely be heavily influenced by whether they perceive the tool as an added burden or a way to simplify and facilitate the student advising they are required to do.

4. Student Engagement with the Mobile Apps was Modest, but Reasonable.

Roughly 20 percent of students assigned to the treatment group for both Cohorts engaged with the mobile apps. Cohort 2's engagement with the apps was somewhat deeper, as students who used the apps watched more videos and completed a higher percentage of quizzes compared to students in Cohort 1. Nevertheless, many at BPCC were discouraged at the low overall rate of engagement among students.

Although the lack of a common pre-test for all students in the analytic sample prevented an analysis of how students' prior achievement influenced their engagement with the apps, anecdotal evidence suggests students who were performing well in their developmental education courses and students who were extremely disengaged from their courses both had low rates of using the mobile apps. In contrast, students who were engaged with the course but struggling academically were more likely to use the apps. Given that the mobile apps were used as a supplemental instructional resource in many classrooms, it is reasonable that students who needed additional support would be more likely to take advantage of the resource compared to students who were already performing well.

5. Despite Low Student Engagement, the Impact Evaluation Results Are Promising.

Although only about one in five students in the treatment group used the mobile apps, the results of the impact evaluation demonstrate that students who used the apps performed significantly better than students in the control group across a variety of outcomes. The results of the impact evaluation for both cohorts is summarized below.

Developmental Education Course Grades

Students given access to the mobile apps outperformed students who were not in their developmental education courses. The smallest benefit was found in Engl 99 of 0.07 grade points and the largest was in Math 98 of 0.19 grade points for an average difference of 0.14 grade points across courses. The statistical analysis produced an equivalent estimate of the average treatment effect of 0.136 grade points, a statistically significant difference ($p = 0.032$).

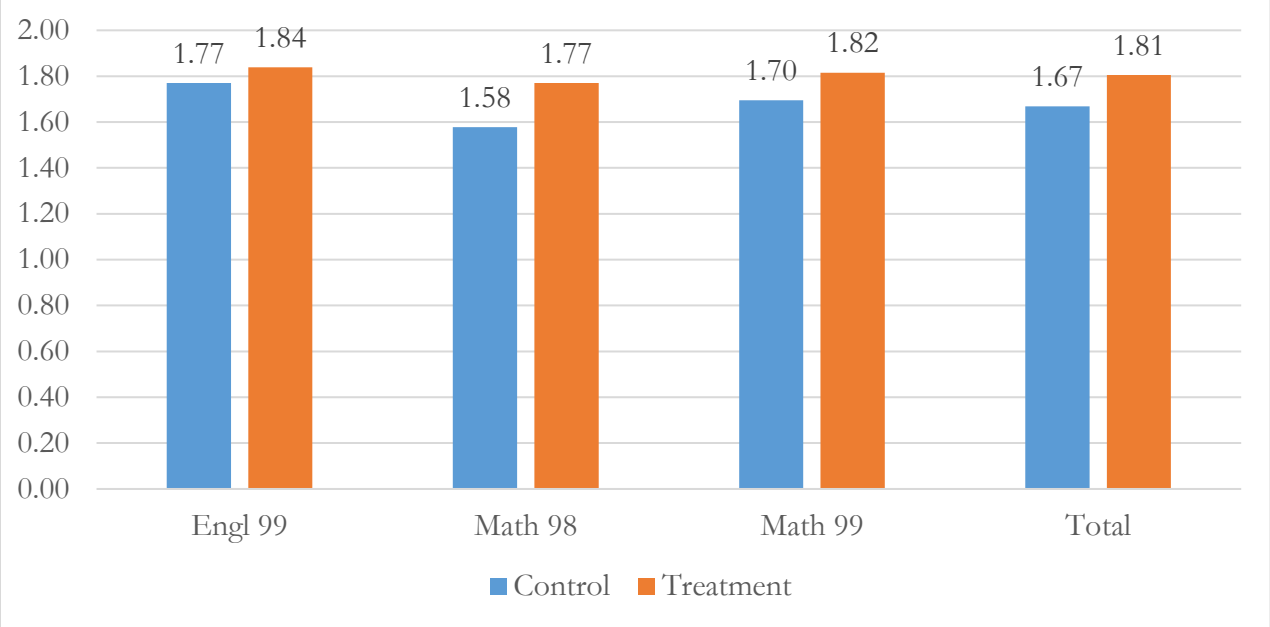

Figure 1: Developmental Education Course Grades for Both Cohorts, by Treatment Status and Course Number

Developmental Education Course Passing

This improvement in course performance translated into a higher likelihood of passing developmental education courses for students assigned to the treatment group. Across both cohorts and all three course numbers, students in the treatment group were more likely to pass their developmental education courses compared to students in the control group. This benefit ranged from a low of 2.6 percentage points in Engl 99 to 9.7 percentage points in Math 99, for an overall benefit of 5.3 percentage points across courses. The estimate from the statistical model of students in the treatment group being 5.5 percentage points more likely to pass their developmental education course was statistically significant ($p = 0.009$).

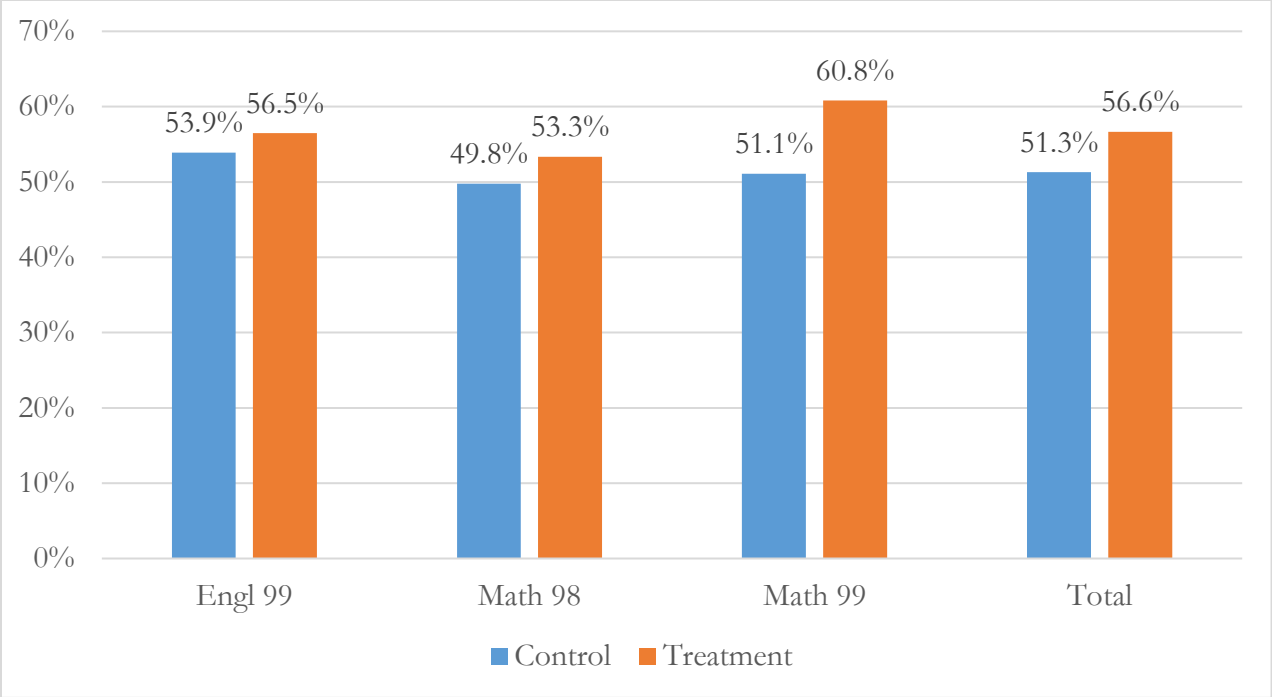

Figure 2: Developmental Education Course Pass Rates for Both Cohorts, by Treatment Status and Course Number

This positive effect of access to the mobile apps for students in Math 99 was also evident in the Cohort 2 students' Fall 2017 GPA. Math 99 students in the treatment group earned a semester GPA 0.28 points higher than did control-group students, and the statistically estimated treatment effect for Math 99 students was 0.30 ($p = 0.026$), a statistically significant difference. There was limited effect of the mobile apps on the Cohort 2 GPA for the other two developmental education courses—Math 98 and English 99—and the effect on Fall 2017 GPA for the combined sample was not statistically significant ($p = 0.275$).

Next Semester Persistence

Surprisingly, while the effects of the mobile apps on student performance in developmental education courses was larger for students in the two math courses, the largest effect on persistence was for students in English 99. The average difference in rates of persistence to the next semester was 3.3 percentage points across all three courses, with treatment students in English 99 demonstrating a 9.3 percent higher persistence rate compared to that of control students. This difference for English 99 students was estimated to be significant ($p = 0.041$) in the statistical models of next-semester persistence. However, the estimate of the average treatment effect across courses of 2.5 percentage points was not found to be statistically significant ($p = 0.247$).

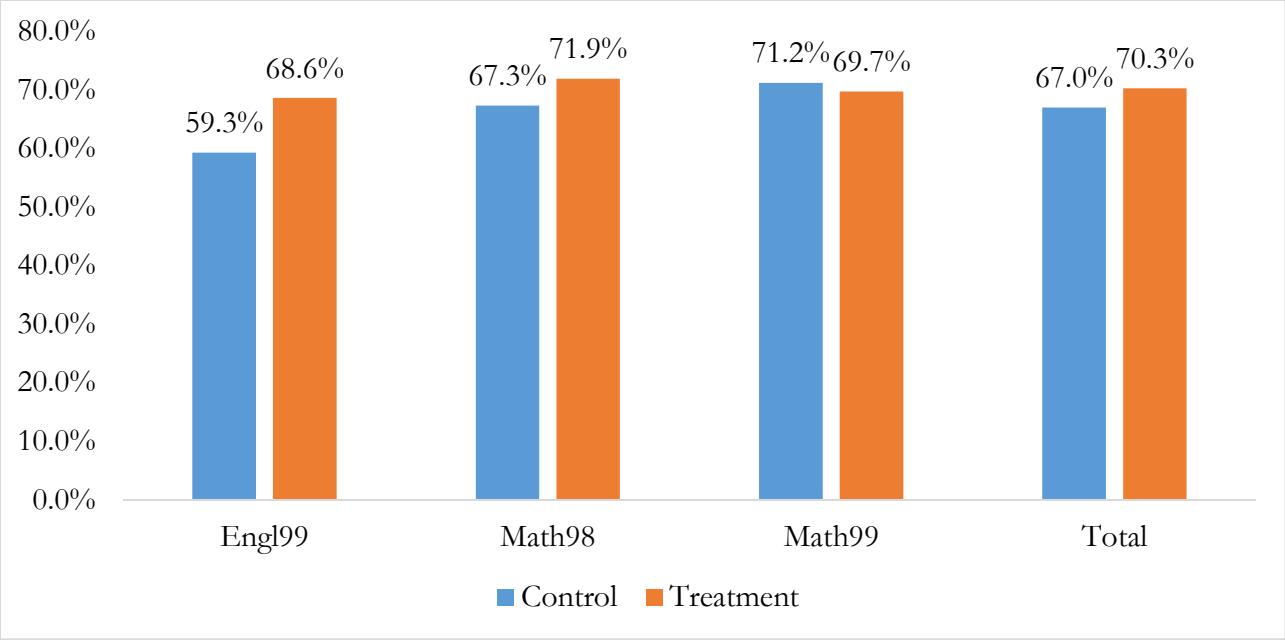

Figure 3: Next Semester Persistence Rates for Both Cohorts, by Treatment Status and Course Number

Next Semester GPA

Perhaps most impressively, in the semester after the intervention, students in the treatment group earned higher GPAs than did students in the control group. Across all three courses, treatment students earned a GPA 0.11 points higher than did control students, and the estimated treatment effect of 0.14 was found to be marginally statistically significant ($p = 0.053$). This effect was driven largely by students in Math 99. The treatment effect for students in this course was 0.37, which was also a statistically significant difference ($p = 0.001$).

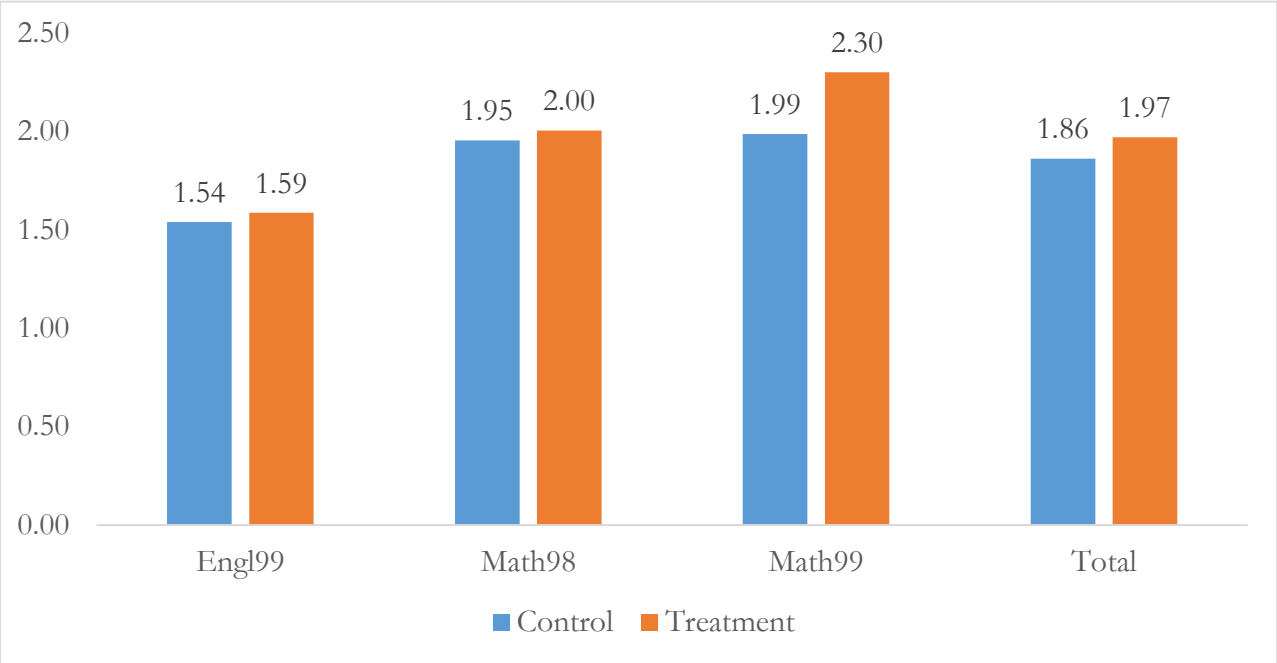

Figure 4: Next Semester GPA for Both Cohorts, by Treatment Status and Course Number

Next Semester Course Passing Rates

Figure 4 shows the percentage of attempted courses that students passed in the semester following the intervention semester. Overall, the treatment group passed 69.1% of the courses they attempted, compared to 66.2% for the control group, a difference of 2.9 percentage points. The estimate of the treatment effect was 3.7 percentage points, a marginally significant difference (p = 0.074). The largest difference was found in Math 99, where students in the treatment group passed 7.7% more of their courses compared to students in the control group. The statistical estimate of the average treatment effect for students in Math 99 of 8.2 percentage points was statistically significant (p = 0.016).

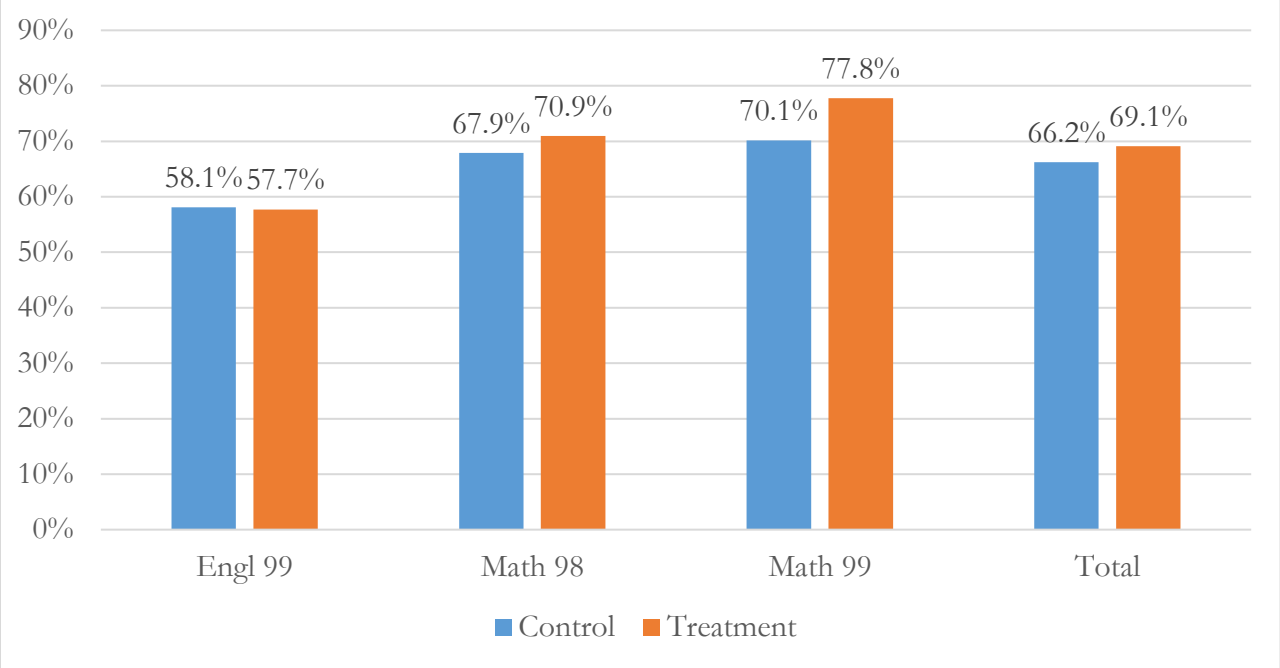

Figure 5: Next Semester Course Passing Rates for Both Cohorts, by Treatment Status and Course Number

Next Semester Credits Earned

We also find students given access to the mobile apps earned marginally more credits in the following semester compared to students in the control group. Students in the treatment group earned 5.62 credits on average in the subsequent semester compared to students in the control group who earned 5.15 credits, a difference of 0.47 credits. This is similar to the statistical estimate of the average treatment effect of 0.46 credits, which was a marginally significant difference (p = 0.072).

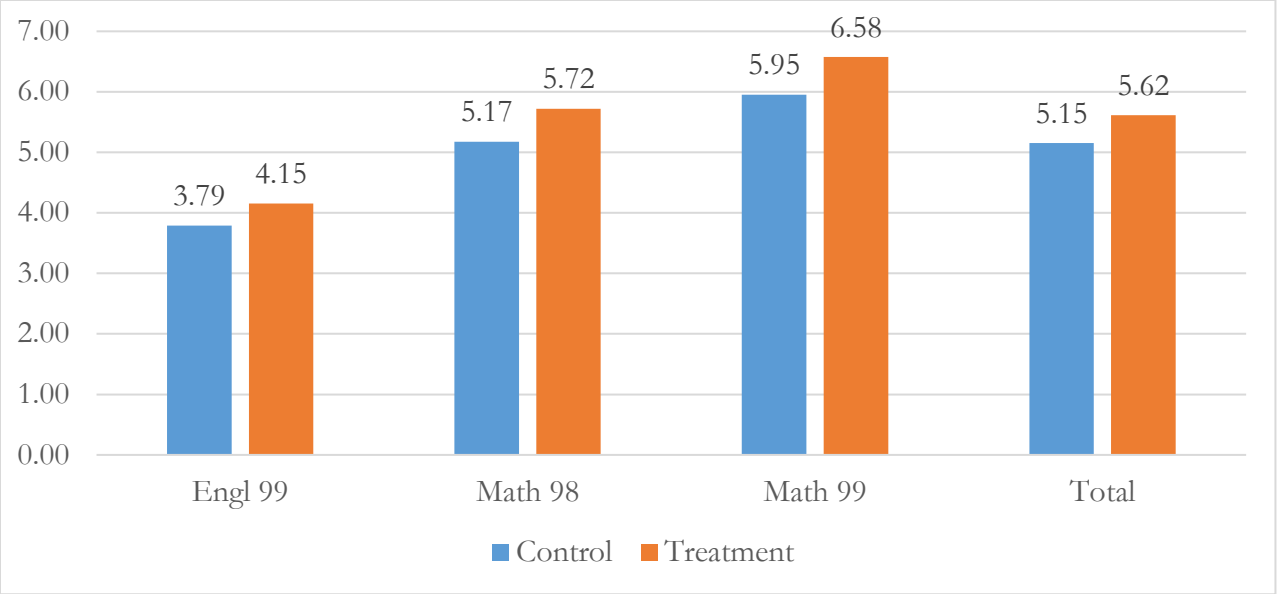

Figure 6: Next Semester Credits Earned for Both Cohorts, by Treatment Status and Course Number

Attainment Analyses

The final outcome investigated in this impact evaluation is the attainment of credentials through Spring 2019. It should be mentioned that the timeframe for evaluating credential attainment is relatively limited. Students in Cohort 2 were enrolled in developmental education courses in Fall 2017, giving them only two years to have earned a credential by Spring 2019 after having begun in developmental education courses. The literature is clear that few students who begin in developmental education earn a credential within two years. Nevertheless, we investigated this outcome to explore whether begin given access to the mobile apps accelerated students' persistence through college sufficiently to produce effects on short-term credential attainment.

Figure 7 displays the rates of credential attainment for the treatment and control groups and across course numbers. Overall, students given access to the mobile apps were 0.5% more likely to complete a credential (certificate or associate's degree) compared to students in the control group, but this difference was not found to be statistically significant ($p = 0.618$). Analyses investigating the effect separately on associate's degree attainment and certificate attainment also found no significant differences between the treatment and control groups, nor were there significant benefits on credential attainment for any of the three course numbers. However, the statistical models estimated that students in the treatment group in Math 99 were 1.7 percentage points more likely to earn any credential compared to students in the control group. Although this difference was not found to be statistically significant, it is a non-trivial improvement in the credential attainment rate. Given that the Math 99 control group's baseline credential attainment rate was 20.1%, a 1.7 percentage point improvement equates to an 8% increase in the credential attainment rate for this subgroup. If these cohorts are followed into the future, this may prove to be a statistically significant difference as well as a practically important one.

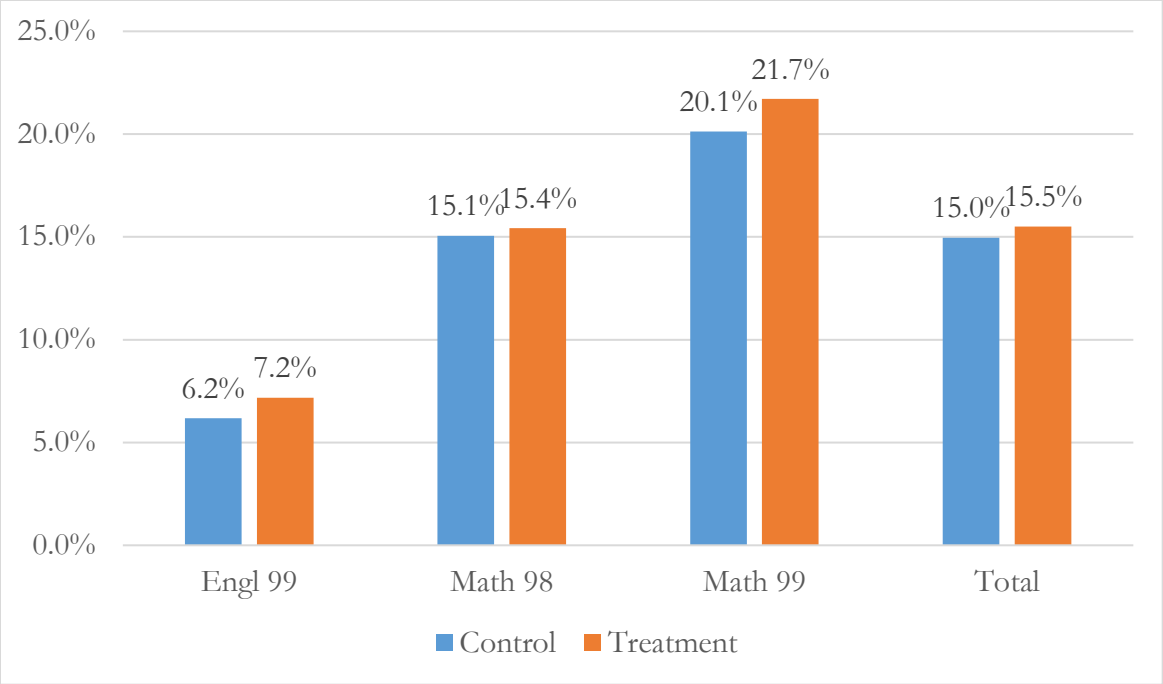

Figure 7: Credential Attainment Rates for Both Cohorts, by Treatment Status and Course Number

Summary of Results of Impact Evaluation

There was considerable variation by course number and semester in the effects of the mobile apps on students' performance in the intervention semester and in the future. Nevertheless, the results of the impact evaluation suggest not only that the mobile apps significantly improved students' performance in their developmental education courses, but also that the apps affected students' likelihood of success in courses the following semester. Although there was insufficient statistical evidence to conclude that being given access to the mobile apps improved students' credential attainment rates, students in the treatment group did complete credentials at higher rates than students in the control group across all course numbers. Following these cohorts further in the future may reveal that the effect on attainment is in fact statistically significant as well as practically important.

Overall, despite being a relatively modest intervention in terms of the resources required to sustain it, the Open Campus mobile apps developed by BPCC significantly improved many important student outcomes. Sustaining and scaling this intervention may allow BPCC to continue to move the needle on the success rates of developmental education students, and the results provide rigorous evidence that a well-designed technological intervention can measurably improve college student performance.

INTRODUCTION

In August 2015, Bossier Parish Community College (BPCC) was awarded a First in the World (FITW) grant from the United States Department of Education (US DOE).

BPCC proposed to fundamentally transform how developmental education content is provided to students in need of remediation by creating mobile apps for three of its most popular developmental education courses:

- English 099 (Fundamentals of Composition),
- Math 098 (Beginning Algebra I), and
- Math 099 (Beginning Algebra II).

This initiative builds upon BPCC's prior development and implementation of *Open Campus,*[3] which provides free and fully online access to developmental education course content to students anywhere in the world.

BPCC's current initiative to develop mobile app versions of this courseware stems from the twofold recognition that providing students with anywhere, anytime access to engaging curricular content can improve performance in courses, and that the student populations most likely to be assigned to developmental education have far higher rates of smartphone ownership than ownership of laptop and desktop computers.

Additionally, BPCC proposed to build an integrated data platform (IDP), incorporating *Open Campus* and other student academic data, into a predictive flow model to reveal empirical patterns of student persistence and learning and to develop interventions targeted at students with low predicted probabilities of success.

The US DOE awarded BPCC nearly $2 million through the FITW grant program due to the innovativeness of BPCC's proposal as well as the strength of its proposed evaluation design.

Impact Evaluation

To determine the impact of the newly developed mobile app courseware on student outcomes, BPCC agreed to randomly assign developmental education course sections to either a *treatment group* or a *control group*. Specifically, course sections would be grouped or "blocked" based on the semester they were offered, the course number (Engl 99, Math 98, or Math 99), and instructor, and then course sections would be randomly assigned to the treatment or control condition within each block. This research design is a type of cluster randomized controlled trials called a multisite or blocked randomized design (Bloom, Bos, & Lee, 1999; Hedges & Hedberg, 2007; Murray, 1998; Murray, Varnell, & Blitstein, 2004).

Students assigned to the treatment group would receive access to the mobile apps, whereas students in the control group would receive the "business-as-usual" condition of traditional in-person developmental education courses.

By comparing the course performance and rates of persistence and attainment for the two groups, the impact evaluation was designed to provide evidence of the impact of the reform on students'

[3] For more on BPCC's *Open Campus*™, see http://www.bpcc.edu/opencampus.

postsecondary outcomes that meets the What Works Clearinghouse's (WWC)[4] evidence standards without reservations, the highest WWC standard.

Implementation Evaluation

The purpose of the implementation evaluation was to assess the degree to which BPCC implemented the intervention with fidelity—in other words, whether they implemented the activities outlined in their FITW grant proposal—as well as to examine the contextual factors that facilitated or impeded implementation.

Various methods were used to examine implementation. First, site visits were conducted to BPCC annually, including during both semesters of the intervention (Spring 2017 and Fall 2017). These site visits included semi-structured interviews with administrators, faculty, advisors, other student-facing staff, and students themselves. All interviews were recorded and transcribed, and the text of the interviews was analyzed to identify key themes that emerged during the interviews.

Second, the evaluator and the FITW team at BPCC participated in conference calls every 1-3 months to discuss progress on various grant activities, such as the development of the mobile apps, the implementation of the IDP, training of BPCC staff to utilize both resources, and the like. Detailed notes were taken during these conversations, which formed the basis for much of the implementation evaluation.

Third, various documents were reviewed that provided more context to the implementation of grant activities. For example, examples of materials that were used in professional development sessions with faculty and staff, one-page handouts for students that explained how to use the mobile apps, and similar documents were provided to the evaluation team by BPCC.

Fourth, data on students' use of the mobile apps was also analyzed to determine students' depth of engagement with the intervention. Although these analyses did not form part of the impact evaluation, they provided additional context into the extent to which students' were using the resource and factors that related to student usage.

Impact Evaluation Sample

The mobile apps were first made available to students during the Spring 2017 semester in Year 2 of grant implementation (2016–2017). As described in BPCC's original FITW proposal, course sections for the three targeted developmental education courses were randomly assigned to the treatment or control group of students. The resulting sample for Cohort 1 included 867 unique students representing 985 enrollments in one of the three courses (some students were enrolled in more than one of the targeted courses). In February 2017, the third-party evaluator conducted a site visit to interview students, faculty, and staff to understand how implementation was proceeding and to gauge stakeholders' perceptions of the mobile apps.

During Year 3 of the grant period, BPCC piloted the mobile apps with a second cohort of students who were enrolled in one of the three targeted developmental education courses during the Fall 2017 semester. A blocked randomized design was once again used to estimate the effect of the mobile apps on student outcomes. The resulting sample for Cohort 2 included 1,051 unique students in 1,142 total

[4] The Institute of Education Sciences' What Works Clearinghouse is available at https://ies.ed.gov/ncee/wwc.

course enrollments. In October 2017, the third-party evaluator conducted another site visit to interview faculty, staff, and students to understand how implementation was proceeding.

Across both interventions, the sample includes 2,036 unique students comprising 2,127 course enrollments. Analyses of outcomes specific to the developmental education courses, such as the grades students received in the courses and whether they passed the courses, used the full sample of course enrollments, allowing individual students to contribute multiple records to the estimation. Analyses of longer term outcomes, such as persistence to the next semester of college and credential attainment, used unique students and restricted the sample to only students enrolled in a single targeted developmental education course (Engl 99, Math 98, or Math 99) to ensure that students were not included in both the treatment and control groups.

The remainder of this report is structured as follows.

- The first section provides a more detailed description of the United States Department of Education's First in the World grant program (US DOE's FITW), including the goals of the initiative and expected activities and results for grantees.
- The second section more fully describes BPCC's FITW proposal.
- The third section discusses the methods that were used for the implementation and impact evaluations.
- The fourth and fifth sections present the results of the implementation and impact evaluations, respectively.
- The sixth and final section concludes by highlighting key findings and identifying factors that appeared to be most critical to the implementation of BPCC's FITW strategies.

US DEPARTMENT OF EDUCATION'S FIRST IN THE WORLD PROGRAM

The FITW grant program is sponsored by the US DOE's Fund for the Improvement of Postsecondary Education (FIPSE). The purpose of the FITW program is to:

> …support the development, replication, and dissemination of innovative solutions and evidence for what works in addressing persistent and widespread challenges in postsecondary education for students who are at risk for not persisting in and completing postsecondary programs, including, but not limited to, adult learners, working students, part-time students, students from low-income backgrounds, students of color, students with disabilities, and first-generation students. (FITW Program Description)[5]

As evidenced by the program's name and its description, FITW is designed to invest in innovations in postsecondary education that have promise to significantly impact the likelihood of success for our most vulnerable student populations.

Given the emphasis on innovations, FITW also requires that grantees contract with third-party evaluators to conduct a rigorous evaluation designed to provide strong evidence of the impact of the initiative. For that reason, FITW grantees generally commit to conducting experimental, and in select cases quasi-experimental, evaluation designs that have a strong likelihood of producing such evidence.

FITW began awarding grants in the 2014 fiscal year and distributed approximately $75 million to 25 applicants, which consisted of individual postsecondary institutions or consortia of colleges and universities. FITW awarded approximately $62 million to 18 grantees during FY 2015, for a total of 43 grants that have been awarded to date. Given the high number of applicants and the relatively small number of grants awarded, FITW is a highly competitive grant program.

[5] For more on the FITW program, see https://www2.ed.gov/programs/fitw/index.html.

BPCC'S CONTEXT AND FITW PROPOSAL

BPCC, located in the Shreveport metropolitan area in northwest Louisiana, serves a large and diverse population of approximately 10,000 students annually. BPCC is also one of the fastest-growing community colleges in the US, with fall enrollment increasing from 4,845 students in 2005 to 8,695 students in 2014.

Demographically, slightly more than 40 percent of the student body is white and another 40 percent is black, with the remaining 20 percent of the student body comprising 7 percent or less each of Hispanic, Asian, multiracial, and students of unknown/other demographics. More than half of undergraduates received Pell grants, an indicator of financial need.

Slightly less than half (48 percent) of the population is younger than 22, with high school students taking college courses making up roughly 10 percent of the student body. A quarter of students are 30 years or older, and the remaining quarter are aged between 22 and 29.

Approximately 75 percent of students come from either Bossier Parish or Caddo Parish, the neighboring Parish in which Shreveport is located.

However, the remainder of the population consists of students from 60 other Parishes across Louisiana; in addition, a small percentage (<3 percent) of students are out-of-state enrollees.

In short, BPCC embodies the community college mission of maintaining a strong focus on providing access to college for students in its local community while simultaneously serving students from a diverse array of geographic, racial, and socioeconomic backgrounds.

The reform that serves as the foundation of BPCC's FITW initiative is *Open Campus,* BPCC's free, fully online suite of courseware for non-credit courses. BPCC faculty and administrators began discussing the idea of *Open Campus* in 2012 while deliberating upon two overlapping issues related to developmental education.

- First, BPCC students in developmental education, like developmental education students across the country, had relatively low rates of success. Few of these students were able to get high marks in the courses on their first attempt, even fewer transitioned into and successfully completed credit-bearing courses, and still fewer were able to persist and attain a degree or certificate.
- Second, faculty and administrators believed that many students were improperly assigned to developmental education courses in the first place and were dismayed at the percentage of students requiring remediation, as high as 57 percent of incoming students in 2014. Many students assigned to developmental education courses were adult learners who had been out of school for some time. Although they may have previously learned the content and developed the skills needed to succeed in credit-bearing courses, they were unable to score at the required levels on the placement exams without a refresher on the content covered in the exams.

Open Campus was therefore devised primarily as a means of allowing students to brush up on core academic content in math, reading, and writing prior to taking the developmental education placement exam. The *Open Campus* courses were designed and built by faculty who traditionally taught in-person developmental education courses at BPCC.

The *Open Campus* courseware consists of video lectures, supplemental reading materials, and quizzes that provide immediate feedback on progress toward mastery of the content. Additionally, the content is modularized, or broken down into small and digestible topics, so students can access the content

either sequentially or topically, focusing on the knowledge and skills for which they need the greatest remediation. The primary goal was to ensure that students placed into the courses that were most appropriate to their skills and academic needs and that students were better prepared for success in those courses.

However, as awareness of *Open Campus* began to grow at BPCC, faculty and administrators learned that a number of students were accessing *Open Campus* modules concurrently during their enrollment in traditional in-person developmental education courses.

Many students reported the benefits of being able to rewatch lectures on particular topics that they did not sufficiently understand during class and retake quizzes to ensure that they grasped the material.

Some faculty therefore began to recommend that students watch the online video lectures through *Open Campus* prior to class so they could more fully discuss questions students had about the materials and then work collectively on assignments in-person, in class.

This pedagogical approach, in which students watch lectures at home and complete "homework" in-class, has been described as the "flipped" classroom or "blended learning" and is becoming an increasingly popular pedagogical approach, as evidenced by the burgeoning literature on the topic (Bersin, 2004; Garrison & Kanuka, 2004; Graham, Woodfield, & Harrison, 2013; Thorne, 2003).

BPCC began piloting *Open Campus* in 2013 and has seen significant access to and engagement with the online curriculum in the past four years. Indeed, BPCC administrators have learned that students from other states, and even other countries, have been accessing *Open Campus* to brush up on their academic skills. Preliminary research on *Open Campus* has also shown positive results.

A one-year (academic year 2014–2015) pilot program of *Open Campus* in desktop and laptop formats demonstrated measurable increases in the number of students who persisted in and completed developmental courses. Students reported that they valued extended opportunities to view lectures they may have missed, review difficult concepts, supplement their lecture notes, and prepare for exams.

Students who are ill, active military or on-call/shift-workers benefit from the knowledge that they may recover any of the covered developmental courses' lecture material missed due to excused absences. High school students preparing for placement tests and nontraditional students considering a return to college reported that they valued an opportunity to practice taking online tests and having portable topic-based tutorials in hand when needed.

Additionally, the reach of *Open Campus* expanded, stemming from BPCC's partnership with Northwestern State University of Louisiana (NSU). Located in neighboring Natchitoches, NSU is a four-year, public university founded in 1884 that currently serves approximately 9,500 students.[6]

BPCC and NSU have established numerous transfer agreements, and one program, BPCC@NSU,[7] offers students who are admitted to NSU—but who do not meet NSU's college-readiness requirements in specific subjects—the opportunity to complete developmental coursework offered by BPCC onsite at NSU.

Students who enroll in these developmental education courses at NSU also use *Open Campus* to supplement their in-person course experiences. However, due to recent changes in state policy that

[6] For more information on Northwestern State University of Louisiana, see https://www.nsula.edu/about-us.

[7] For more information on BPCC@NSU, see https://www.nsula.edu/ece/bpcc.

allow four-year colleges to offer developmental education courses, NSU may no longer be required to partner with BPCC in order to provide remedial coursework to students.

Given the innovativeness and success of *Open Campus,* BPCC administrators involved with the initiative have been invited to present the *Open Campus* concept at a number of professional conferences:

- the American Association of Community Colleges (AACC) Annual Convention (2013, 2014);
- the American Association of Colleges and Universities (AAC&U) General Education and Assessment Conference (2013, 2014);
- the National Academic Advising Association (NACADA) National Conference (2013);
- the NACADA International Conference in the Netherlands (2013);
- the League for Innovations in the Community Colleges International Conference (2014);
- the Sloan International Conference on Online Learning (2013); and
- the National Institute for Staff and Organizational Development (NISOD) International Conference on Teaching and Leadership Excellence (2014).

Although *Open Campus* has flourished by many measures over the past four years, one concern that remained about the availability of *Open Campus* was the fact that many of BPCC's students, a significant proportion of whom can be considered low-income or the "working poor," did not have access to computers or to reliable internet access at home. Students would frequently access *Open Campus* through the computers located in the campus library, but for many working adults and individuals with family responsibilities, this was not significantly more convenient than coming to campus for in-person courses.

Understanding this issue, BPCC proposed in its FITW application to provide selected *Open Campus* developmental education courses on mobile application platforms for both iPhone and Android devices, capable of serving up to 10,000 students at a time on each platform.

Three developmental education courses available through *Open Campus* were initially identified for conversion from desktop to mobile versions: Math 98 (Beginning Algebra I), Math 99 (Beginning Algebra II), and English 99 (Developmental Writing/Fundamentals of Composition).

These three courses were targeted because they have some of the highest enrollment among developmental education courses at BPCC. The mobile apps would be made available to students enrolled in the targeted developmental education courses at either BPCC or NSU (although BPCC@NSU courses may no longer be offered given state policy changes allowing four-year college to provide developmental education instruction without the need to partner with a community college).

After this initial rollout of three courses, additional courses may be selected for the creation of mobile apps. Whether this expansion occurs depends largely upon the results of the third-party evaluation aimed at understanding the degree of success of the initial courses and identifying the factors that were most critical to successful implementation.

By end of the grant performance period, it is expected that the mobile apps will be scaled to a broader campus-wide design that would benefit all students, including underrepresented, underprepared, and/or low-income students. The mobile apps are also expected to be useful as a professional development tool to demonstrate effective pedagogical practices to new and adjunct BPCC faculty.

In addition to developing the mobile apps, BPCC also proposed to implement an integrated data platform (IDP) that would incorporate multiple streams of student data into a predictive flow model to illuminate patterns of student persistence and learning. The institution-specific insights would be used

to inform interventions, policy decisions, and changes in practice that support student persistence and graduation.

The build-out of the platform and the integration of other applications in use at BPCC, including Banner,[8] Canvas,[9] institutional survey data, and tools developed by Civitas Learning,[10] would help BPCC measure the effectiveness of the project interventions on various student subgroups and student outcomes.

Long-term, the integration of data from developmental education students' course performance and engagement with the mobile apps into the integrated data platform would enable better targeting of interventions at students with the greatest risk of dropping out of BPCC due to their performance in developmental education courses—thereby improving student persistence and graduation rates.

[8] Banner is enterprise resource planning (ERP) software from Ellucian; for more information, see https://www.ellucian.com/student-information-system.

[9] Canvas is learning management system (LMS) from Intructure; for more information, see https://www.canvaslms.com/about-us.

[10] Civitas Learning, Inc., provides resources to higher education that help bring together diverse sources of data; for more information, see https://www.civitaslearning.com/about.

INDEPENDENT EVALUATOR

This evaluation is being conducted by Giani Consulting & Evaluation, LLC (GCE). Matt Giani, PhD, is the firm's principal and serves as the lead evaluator for BPCC's FITW initiative.

Dr. Giani received his PhD in education policy and planning from the University of Texas at Austin and holds a master's degree from Stanford University in education policy, organization, and leadership studies.

He previously served as an evaluator for three US Department of Labor Trade Adjustment Assistance Community College and Career Training (TAACCCT)[11] grants and was part of the national research team for the foundation-funded *Credit When It's Due* initiative[12] studying the implementation and impact of reverse credit transfer policies in 15 states.

Dr. Giani now serves as a research scientist for the Office of Strategy and Policy at the University of Texas at Austin.[13] His research has appeared in outlets such as *Review of Higher Education, Research in Higher Education, The Journal of Vocational Education and Training,* and *The High School Journal.*

Giani Consulting & Evaluation is the independent evaluator of BPCC's FITW initiative. In this role, the firm is independently conducting all key aspects of the implementation and impact evaluation. Specifically, GCE is responsible for executing the random assignment of students to the control or treatment groups, collecting and analyzing student outcome data, and estimating and reporting program impacts on the student outcomes.

GCE will also conduct an implementation evaluation to assess the extent to which BPCC implemented the activities it proposed in its FITW grant applications and to understand the factors that inhibited or facilitated implementation. Though the BPCC project director will have an opportunity to review and comment upon the evaluation findings, the findings will not be subject to the approval of the project grantee before being reported.

GCE received Institutional Review Board approval from both BPCC and NSU (Northwestern State University of Louisiana). GCE has also established a Memorandum of Understanding (MOU) with BPCC for the transfer of student data for the purposes of the evaluation in compliance with all state and federal laws governing the privacy and confidentiality of student data, including the Family Educational Rights and Privacy Act (FERPA).

[11] For more on the US Department of Labor's Trade Adjustment Assistance Community College and Career Training (TAACCCT) program, see https://doleta.gov/taaccct.

[12] For more on the Credit When It's Due (CWID) project, see https://occrl.illinois.edu/cwid/products and http://www.washington.edu/ccri.

[13] https://education.utexas.edu/departments/educational-leadership-policy/graduate-programs/education-policy-planning-program/alumni-profiles/matt-s-giani

METHODS

As required by the US DOE and the FITW grant program conditions, the third-party evaluation of BPCC's FITW initiative consists of both an implementation evaluation and an impact evaluation. The following sections describe the methods that were used in these two components of the evaluation.

Implementation Evaluation

Research Questions

The implementation evaluation is guided by two broad research questions:

1) To what extent did BPCC implement the various reforms that constitute its FITW initiative?

2) What factors most influenced implementation?

The first question draws heavily from the logic model BPCC developed to conceptualize the activities and intended outcomes of the initiative, shown in Table 1. This portion of the implementation evaluation is principally concerned with implementation fidelity—namely, to what extent BPCC undertook the activities it originally proposed in its grant application.

Research questions related to this portion of the implementation evaluation take the form of inquiring as to whether specific activities listed in the scope of work have occurred (e.g., "Did BPCC identify and hire project personnel?").

The second question is not limited to assessing the implementation of specific activities listed in BPCC's FITW grant application, but rather is concerned broadly with why implementation proceeded as it did and what factors most influenced implementation. From this perspective, successful implementation depends upon the alignment and coordination of multiple actors and stakeholder groups at different levels of the campus—and both inside and outside BPCC.

A useful heuristic is to consider the role and functioning of six separate factors or stakeholder groups: students, faculty, support and advising staff, FITW staff, BPCC administrators, and the broader social, economic, and policy environment. That is, for BPCC's FITW initiative to succeed:

1) Students must agree to use the project apps that are made available to them;
2) Faculty must effectively incorporate use of the apps into their classroom instruction and utilize the IDP;
3) Support staff must ensure that the apps are developed and working effectively and advising staff must also utilize the IDP;
4) FITW staff must monitor the implementation of the apps, address concerns as they arise, and modify the tools to increase their efficacy;
5) BPCC administrators must provide the structures, incentives, and opportunities necessary to support the implementation of the apps and IDP; and
6) The broader social, economic, and policy environments must remain favorable for the initiative to be implemented, sustained, and scaled.

This portion of the implementation evaluation therefore seeks to uncover and explore the contributions of these constituent elements of the BPCC ecosystem to the implementation of the FITW initiative.

Table 1: BPCC's Logic Model for Its FITW Initiative

Note: This BPCC logic model table has been lightly edited for clarity to readers outside of the BPCC community.

ACTIVITY	OUTCOME	GOAL	TIMELINE
Identify and hire project personnel.	Capacity to administer grant is built. Project fully staffed within 90 days of start date.	Three *Open Campus* modules embedded into courses	Y1Q1
Designate campus office space and purchase supplies for project personnel.	Physical space is provided and offices are established for new hires within 90 days.		Y1Q1
Order and install equipment and supplies.	Capacity to collect and track participant outcomes is increased. Servers are ordered and installed, workstation is installed, Mediasites hardware and media storage are fully operational by end of third quarter.		Y1Q2–Y1Q3
Procure consultant for app vendor selection process.	Professional expertise is identified to inform the project. Vendor selection criteria are formulated.		Y1Q2–Y1Q3
Contract with integrated data platform (IDP) to determine data gathering features needed for app development.	Professional expertise is identified to inform the project.		Y1Q2–Y1Q3
Procure subcontracted vendor for app development.	Professional expertise is identified to inform the project. Mobile app developer is procured; subcontract is developed by end of third quarter.		Y1Q2–Y1Q3
Expand existing instructional modules for pilot population to mobile app format for all FTIC (first time in college) population.	Existing *Open Campus* templates are converted to formats compatible with mobile devices.		Y1Q2–Y1Q3
Develop mobile app concept and begin work with developer.	Mobile-device app requirements are identified; conceptual art, wireframes, and designs developed and finished; domain name and server space allocated; working timeline established.	New mobile app scaled to dev ed,	Y1Q3–Y1Q4

ACTIVITY	OUTCOME	GOAL	TIMELINE
Convert existing modules to mobile app format.	Availability of tutorial support for students is scaled. Existing modules are converted and available for pilot use by end of first year.	student success, and gateway courses	Y1Q4–Y2Q1
Incorporate instructional materials into mobile app.	Existing instructional materials are incorporated into mobile app format by end of first year.		Y1Q4
Identify target population for pre-project placement testing.	Experimental and control groups for beta testing are identified from a universe of all students enrolled that semester.		Y2Q1
Conduct baseline data collection.	Capacity to collect and compare valid data is established. Initial "untreated" measurements are gathered among target population before beta testing begins.		Y2Q1
Solicit student feedback on design, levels of confidence/anxiety, usability of mobile app.	Formative evaluation begins. Through focus groups, surveys, and interviews, information is collected about student perceptions and use of app.		Y2Q2
Share beta version of mobile app with selected group of students, public.	Formative evaluation feedback continues as the beta version goes live; Initial tests will inform future refinements of the mobile app.		Y2Q3
Collect data on mobile app design usability, challenges, and strengths of features.	Initial data collected; by end of second year, modifications made to mobile app beta version to reflect predominant user preferences.		Y2Q3–Y2Q4
Continue continuous feedback and improvement loop to refine mobile app.	Mobile app features are refined based on feedback and beta test results through third year.	Continuously refined mobile app that is available for all students.	Y2Q4–Y3Q4
Work with faculty to integrate mobile app in standard developmental ed math course curricula.	Increase number of faculty and staff who attend professional development events related to *Open Campus* mobile app implementation.		Y2Q1–Y4Q1
Transition funding of new hire for app administration to college operational funds.	Continued progress following grant period; the work is sustained.		Y4Q4

Research questions that fall within this portion of the implementation evaluation include:

1) To what extent did social, economic, and policy changes influence implementation?
2) How supportive was BPCC administration of the FITW initiative?
3) Who was part of the FITW support team, and what roles did they play in supporting the initiative?
4) How did support and advising staff at BPCC contribute to the development and implementation of the mobile apps and integrated data platform (IDP)?
5) How did faculty respond to and embrace the FITW initiative, and what training and professional development opportunities were provided to them in order to increase their support?
6) To what extent did students use the mobile apps, and what factors influenced their degree of utilization?
7) Overall, what were the greatest barriers to and facilitators of implementation at BPCC?

In the first year of the FITW grant (2015–2016), BPCC stakeholders focused their efforts on developing the mobile apps and communicating the design and purpose of the initiative to various constituencies on campus but did not begin implementing the intervention this year. The implementation evaluation in the first APR therefore focused on BPCC's social, economic, and policy contexts and various stakeholders' perceptions of the initiative. The remaining APRs have focused largely on the implementation of activities proposed in BPCC's FITW grant application and factors promoting or inhibiting successful implementation.

Implementation Evaluation Methods

Four primary methods were used to evaluate the implementation of the mobile apps at BPCC. First, the third-party evaluator conducted annual site visits each year of the grant. During site visits, interviews and focus groups were conducted with BPCC administrators, FITW staff, advising staff, instructors who were teaching one of the three developmental education courses included in the intervention, and students enrolled in one of the targeted courses. Prior to the site visit, separate semi-structured focus group protocols were developed for each of the stakeholder groups. All focus groups were recorded and professionally transcribed. Responses for each focus group were then coded and themed, and responses between focus groups were triangulated.

Second, the evaluator and BPCC developed surveys to gauge input from broader groups of stakeholders on various topics related to implementation. For example, BPCC developed and administered feedback surveys for faculty and staff who participated in professional development sessions related to both the mobile apps and the IDP, and the independent evaluator administered student and instructor surveys to gauge their perceptions of the mobile apps. However, response rates to the survey were generally quite low for both the student and faculty/staff surveys, preventing the survey data from producing reliable insights into implementation.

Third, the evaluator held regular phone calls with FITW staff at BPCC throughout the year to gauge how implementation was proceeding. These calls occurred on a roughly monthly basis. FITW staff also provided the evaluator with various documents related to implementation, such as training and professional developmental materials, handouts for students that explained how to use the mobile apps, and related materials.

Fourth, the evaluator reviewed data on students' usage of the mobile apps. While these analyses did not form part of the impact evaluation, they provided additional evidence as to the depth of students' engagement with the mobile apps and factors related to students' usage of the apps.

Impact Evaluation

Impact Evaluation Research Questions

The overarching research question guiding the impact evaluation can be stated as: What was the impact of access to the mobile applications on the postsecondary outcomes of developmental education students? The outcomes analyzed in the impact evaluation include short- (e.g. course performance), medium- (e.g. semester-to-semester persistence), and long-term (e.g. postsecondary attainment) outcomes. BPCC's FITW grant was awarded in 2015 and the four-year grant period ended on September 30, 2019. Student outcomes were therefore tracked through Spring 2019, or approximately two full years from the first semester of implementation of the mobile apps. For all primary research questions, a sub-question investigates the extent to which the effect of the mobile apps varied across the three courses—in other words, whether courses moderated the effect of the app on student outcomes.

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1) What is the effect of access to mobile apps on the rates of students passing one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    a. Does this effect vary by course number?
2) What is the effect of access to mobile apps on the grades students receive in the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    b. Does this effect vary by course number?
3) What is the effect of access to mobile apps on the semester-to-semester persistence of students enrolled in one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    c. Does this effect vary by course number?
4) What is the effect of access to mobile apps on the next semester GPA of students enrolled in one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    d. Does this effect vary by course number?
5) What is the effect of access to mobile apps on the overall course passing rates during the next semester of students enrolled in one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    e. Does this effect vary by course number?
6) What is the effect of access to mobile apps on the credits earned during the next semester of students enrolled in one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    f. Does this effect vary by course number?
7) What is the effect of access to mobile apps on the credential attainment rates of students who enrolled in one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    a. Does this effect vary by course number?

Impact Evaluation Methods

To produce evidence of the effects of this intervention that meets the What Works Clearinghouse's (WWC) Evidence Standards without reservations, students were randomly assigned to either the treatment or the control group using a stratified cluster randomized trial research design, also known as a multisite or blocked randomized design (Hedges & Hedberg, 2007; Murray, 1998; Murray, Varnell, & Blitstein, 2004). We elected to use a group random assignment rather than individual assignment given the threat of "contamination," namely students who would be given access to the mobile apps sharing

access with control students enrolled in the same developmental course sections. Additionally, faculty members who will be teaching the developmental education courses expressed a strong preference for cluster randomization to eliminate the need to assist students in the same classrooms using different materials and technologies.

The four strata used in the randomization are cohort/semester (Spring 2017 or Fall 2017), college (BPCC or NSU), developmental education course numbers (Math 98, Math 99, and English 99), and instructors. For every instructor who taught more than one course section of the same course number at the same college in the same semester, that instructor's specific course sections were randomly assigned to the two groups. The remainder of the course sections, or those taught by instructors who only taught one course section of the same course number at the same college in the same semester, were then randomized within course number within college. The result was 17 instructor by course number by college blocks during the Spring 2017 intervention and 14 blocks during the Fall 2017 intervention for a total of 31 blocks, each of which contained a treatment and control group. These blocks, and the number of students assigned to the treatment and control groups within each block, are reflected in Table 2.

Table 2: Student Enrollment by Randomization Block for Both Cohorts

Block ID	Cohort	BPCC/NSU	Course	Instructor	Control	Treatment	Total
1	Spring 2017	BPCC	Engl 99	Engl 99 A	18	23	41
2	Spring 2017	BPCC	Engl 99	Engl 99 B	30	29	59
3	Spring 2017	BPCC	Engl 99	Engl 99 C	18	27	45
4	Spring 2017	BPCC	Engl 99	Engl 99 D	22	24	46
5	Spring 2017	BPCC	Engl 99	Engl 99 E	28	26	54
6	Spring 2017	NSU	Engl 99	Engl 99 F	14	19	33
7	Spring 2017	BPCC	Math 98	Math 98 A	29	24	53
8	Spring 2017	BPCC	Math 98	Math 98 B	37	32	69
9	Spring 2017	BPCC	Math 98	Math 98 C	29	27	56
10	Spring 2017	BPCC	Math 98	Math 98 D	24	29	53
11	Spring 2017	BPCC	Math 98	Math 98 E	23	32	55
12	Spring 2017	BPCC	Math 98	Math 98 F	56	30	86
13	Spring 2017	NSU	Math 98	Math 98 G	13	16	29
14	Spring 2017	BPCC	Math 99	Math 99 A	34	28	62
15	Spring 2017	BPCC	Math 99	Math 99 B	33	33	66
16	Spring 2017	BPCC	Math 99	Math 99 C	87	56	143
17	Spring 2017	NSU	Math 99	Math 99 D	22	8	30
18	Fall 2017	BPCC	Engl 99	Engl 99 G	31	31	62

19	Fall 2017	BPCC	Engl 99	Engl 99 H	31	31	62
20	Fall 2017	BPCC	Engl 99	Engl 99 I	31	32	63
21	Fall 2017	BPCC	Engl 99	Engl 99 J	31	20	51
22	Fall 2017	BPCC	Engl 99	Engl 99 K	30	62	92
23	Fall 2017	BPCC	Math 98	Math 98 H	35	35	70
24	Fall 2017	BPCC	Math 98	Math 98 I	35	35	70
25	Fall 2017	BPCC	Math 98	Math 98 J	31	30	61
26	Fall 2017	BPCC	Math 98	Math 98 K	34	11	45
27	Fall 2017	BPCC	Math 98	Math 98 L	35	22	57
28	Fall 2017	BPCC	Math 98	Math 98 M	57	67	124
29	Fall 2017	BPCC	Math 99	Math 99 E	72	35	107
30	Fall 2017	BPCC	Math 99	Math 99 F	35	35	70
31	Fall 2017	BPCC	Math 99	Math 99 G	79	129	208
Total					1084	1038	2122

A master list of all course sections for the three targeted developmental education courses was generated near the beginning of the Spring 2017 and Fall 2017 semesters. These course sections were provided to the third-party evaluator, who conducted the randomization. This randomization occurred on Saturday, January 21, 2017, after the last day that students were able to register for new courses or change course sections (Friday, January 20, 2017) for the Spring 2017 intervention. The timing of the randomization eliminated the threat of joiners (students being added to the sample after randomization) and mitigated the risk of contamination (students moving from one assignment to another by changing course sections).

However, this date was roughly a week after the Spring 2017 semester had begun, making it a challenge for instructors to effectively implement the mobile apps. For the Fall 2017 cohort, the randomization occurred on Sunday, August 6, 2017. This allowed instructors to be notified of whether they would have access to the apps in their classes during the professional development sessions that occurred on August 7-8, 2017. The first day of class was on August 11, 2017. Although students may have enrolled in Fall 2017 courses through August 17, 2017, no joiners were included in the analysis.

Statistical Models

As the use of a cluster randomized design has the potential to result in biased estimates of the standard error of the treatment effect stemming from the introduction of level-2 clustering (Hedges & Hedberg, 2007), multilevel modeling techniques were used to account for this clustering (Raudenbush & Bryk, 2002) with students nested in course sections. Multilevel linear regression models were used for both continuous and dichotomous outcomes. For dichotomous outcomes, linear regression was used rather than logistic regression both to facilitate interpretation and because the outcomes under study have moderate probability ranges (20-80%) that make linear regression an appropriate choice (Hellevik, 2009).

Two statistical models were used. The first included fixed block effects and a fixed treatment effect to estimate the average treatment effect across blocks. The statistical equation for the model may be described as:

Model 1

Level-1: Student Level

$$Y_{ij} = \beta_{0j} + \sum_{m=1}^{M} \beta_{1.m} X_{mij} + \varepsilon_{ij}$$

Level-2: Cluster (Course Section) Level

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(T_j) + \sum_{p=1}^{P-1} \gamma_{02.p} Block_{pj} + \mu_{0j}$$

$$\beta_{1.mj} = \gamma_{1.m0}$$

Where,

Y_{ij} = the *outcome* for the i^{th} student in the j^{th} course section.

β_{0j} = the intercept for course section *j*.

$\beta_{1.mj}$ = the effects of student covariates in course section *j*.

X_{mij} = the m^{th} of M additional covariates for student *i* in course section *j*.

ε_{ij} = a residual error term for student *i* in course section *j*.

γ_{00} = the mean intercept

γ_{01} = the treatment effect

T_j = 1 if course section *j* is assigned to treatment, and = 0 if course section *j* is assigned to comparison.

$\gamma_{1.m0}$ = mean effect of student covariate *m*.

$Block_{pj}$ = 1 if the course *j* was assigned to the treatment or comparison condition within the randomization block *p*, and = 0 otherwise.

$\gamma_{02.p}$ = the effect of block *p*.

μ_{0j} = random intercept term – deviation of course section *j*'s mean from the grand mean, conditional on covariates; assumed to be normally distributed with mean 0 and variance τ_{00}^2.

The second model estimated the extent to which the effect of treatment varies across course numbers by adding block by treatment interaction terms. The equation for this model can be described as:

Model 2

Level-1: Student Level

$$Y_{ij} = \beta_{0j} + \sum_{m=1}^{M} \beta_{1.m} X_{mij} + \varepsilon_{ij}$$

Level-2: Cluster (Course Section) Level

$$\beta_{0j} = \gamma_{00} + \sum_{p=1}^{P-1} \gamma_{02.p} Block_{pj} + \sum_{p}^{P-1} \gamma_{03.p} (T_j * Block_{pj}) + \mu_{0j}$$

$$\beta_{1j} = \gamma_{10}$$

$$\beta_{1.m} = \gamma_{2.m0}$$

Where,

$Block_{pj}$ = 1 if the course section *j* was assigned to the treatment or comparison condition within the (randomization or matching) block *p*, and = 0 otherwise.

$\gamma_{02.p}$ = the effect of block *p*

$\gamma_{03.p}$ = the difference in the treatment effect for block *p* and the treatment effect for the reference block.

All other terms are defined as described in the previous model.

Samples

This Annual Performance Report includes analyses of both cohorts of students (Spring 2017 and Fall 2017). For the Spring 2017 cohort, the total number of students who were enrolled in one of the targeted courses at the time of randomization included 867 unique students in 985 total course sections. Of the 867 unique students, 758 only enrolled in one of the three courses, 100 enrolled in two courses, and 9 enrolled in all three courses. Five of these students did not receive a grade for their developmental education course for an attrition rate of 0.6%. Of the remaining 980 course enrollments, 463 (47.2%) were in treatment group course sections and 517 (52.8%) were in control group classrooms. Of the 757 students who enrolled in only one course, 366 (48.3%) enrolled in a course section assigned to the treatment group and 391 (51.7%) enrolled in a course section assigned to the control group.

For the Fall 2017 cohort, the total number of students who were enrolled in one of the targeted courses at the time of randomization included 1,051 unique students in 1,142 total course sections. Of the 1,051 unique students, 960 only enrolled in one of the three courses and 91 enrolled in two courses. No student enrolled in all three courses.

The randomization produced a relatively balanced distribution of assignments, with 575 course enrollments (50.4%) in the treatment group and 567 (49.6%) in the control group. Among the sample of 960 students with only one course enrollment, 482 students (50.2%) were assigned to the treatment group and 478 (49.8%) were assigned to the control group. No joiners, or students who enrolled after the time of randomization, were included in the analysis.

Although randomization occurred after the last date for course changes for the Spring 2017 intervention, randomization took place slightly earlier in the Fall 2017 semester in order to give instructors more time

to prepare for using the apps in their courses (or not, depending on their assignment). While only five of the 985 student course records did not have credit or grade information for their assigned developmental education course at the end of the semester during Spring 2017 (attrition rate = 0.6%), for the Fall 2017 semester 112 of the 1,142 course records did not have a grade (attrition rate = 9.8%). The attrition rate for the control group was 10.9% and the rate for the treatment group was 8.7%, for a differential attrition of 2.2%.

Neither the overall or differential attrition rate poses a threat to the validity of the study under WWC's conservative attrition standard. Course records without a grade will be considered censored and excluded from the grade analyses per IES recommendations (Puma, Olsen, Bell, & Price, 2009). However, for the analysis of whether students passed the course, we will consider students who withdrew or otherwise did not receive a grade as having not passed the course, and these records will be kept in the analytic sample.

The analytic sample used in each model depends upon the research question being addressed. For models of outcomes that are specific to the individual developmental education courses, the entire sample of was be used given the limited threat of contamination. For example, it is unlikely that a student getting access to the mobile app for Math 98 would substantively affect her performance in English 99, even if she was assigned to a control group section in English.

However, for outcomes related to overall course performance and longer-term outcomes, an additional inclusion criterion is applied requiring students to have only enrolled in one of the three targeted course sections in that semester to ensure students are not part of both the treatment and control group.[14]

Variables

The models include student-level covariates (race/ethnicity, gender, Pell receipt, age, credits attempted prior to the semester of the intervention, and credits earned prior to the semester of the intervention) as well as a level-2 random intercept to account for variation in the effects of classrooms/instructors on student outcomes. Although standardized assessments were administered to students, no more than 40% of the sample took the same assessment, and roughly 10% of the sample did not have a score for any standardized assessment. For this reason credits attempted and earned prior to the intervention semester were used as a proxy for academic preparedness. Fixed effects for the 31 college by course number by instructor blocks were added to the model to account for the stratified cluster randomized design.

[14] Note that the eligibility criterion (that student enrolled in only one course) for inclusion in this sample is based on a student behavior that occurred prior to randomization, maintaining the integrity of the random assignment.

IMPLEMENTATION EVALUATION RESULTS

As discussed in the methods section, the implementation evaluation has two parts. The first can be described as the implementation fidelity evaluation. This portion of the evaluation is principally concerned with the extent to which BPCC implemented the activities that comprised the reform's logic model as listed in BPCC's FITW proposal, or *whether* activities were implemented. The second examines the implementation context, including the current and potential roles of various BPCC stakeholders in implementing the initiative and critical factors inhibiting or facilitating implementation. This portion of the evaluation assesses *how* and *why* BPCC implemented the strategies it did.

Implementation Fidelity Evaluation

The implementation fidelity evaluation focuses on those activities that were implemented by the end of the fourth grant year, or through September 2019. Additionally, the description of implementation activities focuses on those activities which were proposed to continue through at least the third grant year. For example, the activity "order and install equipment and supplies [and] hire consultant for application vendor selection process" was an activity that only occurred in Year 1. In contrast, the activity "continuous feedback improvement loop; refine mobile app" was proposed to begin in Year 1 and continue throughout the grant. The implementation of this activity is therefore discussed in greater detail. BPCC in fact proposed no new activities to begin in Year 3 or Year 4, meaning the implementation evaluation focuses on the continuation of activities begun in Year 2 through the end of the grant.

Table 3 contains a summary of the implementation fidelity evaluation. The table lists each activity in BPCC's logic model the college indicated it would implement during Years 1-4 of the grant. Table 3 also includes two sets of ratings for each activity. The initials "MG" refer to the independent evaluator's ratings of implementation, while "AM" refers to the project director's ratings of implementation. The columns in the table represent six categories of implementation. Definitions of these categories are as follows:

- Discontinued – An activity that was planned in the original FITW grant application is no longer being planned.
- Planning – Project personnel are in the planning stages of an activity, with implementation to follow in the near future.
- Implementing – Implementation has commenced for the given activity but has not yet been completed.
- Implemented – The activity has been fully implemented by the college, and no additional actions related to that activity are planned or required.
- Sustainability – A formal plan has been put in place for the activity to continue beyond the termination of the grant period.
- Scale-up – The activity is being expanded beyond its original scope as described in the grant proposal.

Only some activities were intended to be sustained or scaled after the end of the grant. For example, the contract with the vendor to develop the mobile apps was intended to occur during the grant period but not extend after the grant. In contrast, BPCC planned to transition staff hired on grant funds to more sustainable revenue sources in order to keep these personnel on staff. The discussion below will only focus on sustainability and scale-up for those activities that were intended to be sustained.

Table 3: Evaluation of Implementation of Years 1 and 2 Activities Included in BPCC's Logic Model

	Discontinued	Planning	Implementing	Implemented	Sustained	Scaled-Up
Year 1 (2015-16)						
Identify and hire project personnel				MG AM		
Designate campus office space and purchase supplies for project personnel				MG AM		
Order and install equipment and supplies				MG AM		
Procure consultant for app vendor selection process.				MG AM		
Contract with IDP to determine data gathering features needed for app development				MG AM		
Procure subcontracted vendor for app development				MG AM		
Expand existing instructional modules for pilot population to mobile app format for all FTIC population				MG AM		
Develop mobile app concept and begin work with developer				MG AM		
Convert existing modules to mobile app format					MG AM	
Incorporate instructional materials			AM	MG		
Year 2 (2016-17)						
Identify target population for pre-project placement testing					MG AM	
Conduct baseline data collection				MG AM		

	Discontinued	Planning	Implementing	Implemented	Sustained	Scaled-Up
Solicit student feedback on design, levels of confidence/anxiety, usability				MG AM		
Share beta version with selected group of students, public				MG AM		
Collect data on design usability, challenges, and strengths of features				MG AM		
Continue continuous feedback and improvement loop to refine mobile app			MG AM			
Work with faculty to integrate mobile app in standard dev ed math course curricula			MG AM			
Transition new hire app admin to college operational funds		MG AM				

Contract with Integrated Data Platform (IDP)

As discussed in prior Annual Performance Reports, BPCC contracted with Civitas Learning to begin implementation of three components of the IDP: a base analytics platform called *Illume* that uses predictive modeling to identify at-risk students, a tool called *Inspire* (formerly known as Inspire for Advisers) that serves as a platform for targeting interventions and outreach to at-risk students, and a third tool called *Illume Impact* that enables colleges to estimate the effect of specific programs and interventions on student outcomes by selecting a matched control group. BPCC proposed for the FITW grant funds to cover the costs of Inspire, and BPCC administration agreed to fund the Illume and Illume Impact tools.

A variety of technical challenges, including the centralization of data collection and management systems by the Louisiana Community and Technical College System (LCTCS) and the development of a dashboard view within Banner, the student data system used by LCTCS colleges, impeded implementation of the Illume and Illume Impact aspects of the IDP. However, BPCC fully implemented the Inspire for Advisers tool. By the close of Year 2, a total of 150 BPCC personnel – 76% of all BPCC full-time faculty and 52% of front-line staff – had been trained in IDP features most applicable to each departmental area.

Training on the Inspire tool continued in Years 3 and 4 of the grant. By the end of the final grant year, more than 75% of faculty and 75% of front-line advising staff had been trained on the use of the tool. Approximately 100 faculty and staff used the tool independently after they received training, resulting in roughly 2,000 individual logins by faculty and staff and more than 11,000 outreaches to students.

Continuous feedback improvement loop; refine mobile app

The first phase of the mobile apps was designed to make a number of content modifications to the resource and convert the desktop version of *Open Campus* into a mobile responsive and adaptive version of the tool. The content modifications focused on shortening the pre-recorded lectures from an average of 15–20 minutes to 2–3 minutes.

This modularization was planned given early feedback from students and instructors that the videos were too long, as well as analytics from the videos themselves that showed viewers often did not watch the full videos before exiting. This modularization was completed in the first two years of the grant, and the Phase 1 version of the app that launched in grant Year 2 included these shortened videos. Student and instructor feedback and analytics from the videos suggest this strategy was effective, as viewers were much more likely to complete the shortened videos than the previous longer versions.

However, the Phase 1 version was not a full mobile application that students could download from services such as the Apple App Store or Google Play and install on their devices. Rather, a short-cut to the mobile-friendly version of *Open Campus* could be installed on the home screen of students' mobile phones. While installing *Open Campus* in this way made the tool resemble and function like a mobile app, both students and instructors were less familiar with this process than downloading apps through traditional channels.

Additionally, Phase 1 of the mobile apps did not have functionality that would allow instructors to login and view their students' engagement with the apps. Rather, BPCC administrators were required to send instructors weekly snapshots of student engagement, including which students logged into the tool and how they used it. Instructors reported during the Year 2 site visit that the lack of this functionality hindered their support for the tool.

In Year 3 of the grant, BPCC contracted with InsiteHub, the same vendor that developed the first phase of the apps, to develop fully functional mobile apps that can be downloaded through the App Store and Google Play. These Phase 2 mobile apps were rolled out to BPCC students, faculty, and staff in the final year of the grant and are currently available through the Apple App Store and Google Play. The new features of the Phase 2 apps and how students and faculty responded to them will be discussed further in the implementation context evaluation section.

Work with faculty to integrate mobile app in standard developmental education math courses

One aspect of sustainability of the mobile apps consists of instructors fully integrating the mobile apps into their courses. This may consist of faculty assigning students videos to watch for homework, requiring them to complete quizzes within the mobile apps, among other activities. In order to maintain faculty buy-in for the FITW initiative and ensure instructors did not perceive the reform as a top-down mandate, BPCC administrators were flexible during the pilot periods in regards to how instructors could use the apps in their classrooms. However, they simultaneously recognize that the usefulness of the apps will be limited if instructors solely use them as supplemental, and optional, resources for students.

After Phase 2 of the mobile apps was rolled out in the final year of the grant, BPCC staff and administrators provided additional professional development to faculty on how to effectively incorporate the apps into their courses. However, the integration of the mobile apps into the core teaching and learning experience of developmental education courses is still ongoing. The most common use of the mobile apps continues to be as a supplemental resource offered to students before taking their developmental education placement exams or mentioned at the beginning of the semester in developmental education courses. The following section provides additional detail regarding the factors that facilitated and impeded faculty and student use of the mobile apps in developmental education classrooms.

Implementation Context Evaluation

The previous section was focused principally on fidelity of implementation, namely whether BPCC had implemented the various activities that comprised the initiative's logic model included in its original FITW grant application. The current section dives deeper into the contextual factors of the intervention in order to explore how the initiative was actually implemented and why BPCC experienced the challenges and successes it did during implementation. This section draws more extensively on the findings from the focus groups and interviews conducted during the site visit, as well as regular phone conversations with BPCC staff overseeing the FITW initiative. The research questions that were focused on during the implementation context evaluation were:

1) How did support and advising staff at BPCC contribute to the development and implementation of the mobile apps and IDP?
2) How did faculty respond to and embrace the FITW initiative, and what training and professional development opportunities were provided to them in order to increase their support?
3) To what extent did students utilize the mobile apps, and what factors influenced their degree of utilization?
4) Overall, what were the greatest barriers to and facilitators of implementation of the mobile apps and IDP at BPCC?

Support and Advising Staff's Contributions to Development and Implementation of Mobile Apps and Integrated Data Platform

Format of the Mobile Apps

A key feature of the phase one version of the mobile apps is that they were not available for download through app repositories built into most mobile phones, such as the App Store (for Apple devices) or Google Play (for Android devices). Instead, BPCC developed a new website to host this version of *Open Campus*. The website was developed with a responsive design that scales automatically to the screen size of the device being used, a key difference from the desktop version of *Open Campus*. After opening the site on a mobile device and logging in, the user can save a shortcut to the site on their phone.

Once that step is completed, the resource functions very similarly to a mobile app. However, instructors and students were somewhat unfamiliar with this process, and there were strong recommendations for BPCC staff to develop a fully functional mobile app. In Year 3 of the grant, BPCC staff contracted with a vendor (InsiteHub) to develop Phase 2 of the apps. In addition to adding various features to the software, this version of the apps will also be available to download through app repositories such as the App Store and Google Play. In interviews, instructors reported strong approval of BPCC staff's strategy to develop full mobile apps.

Training and Professional Development

A select group of faculty members were instrumental in developing the content for the *Open Campus* mobile apps. These instructors had been receiving updates on the progress of the apps and had been testing functionality in the apps throughout the fall semester. The majority of faculty members did not receive substantive training on the mobile apps until a professional development session immediately preceding the Spring 2017 semester. Although holding the training so close to the beginning of the semester was a challenge, faculty reported positive experiences of the session. One instructor accounted her recollection of that training:

> What they showed us in the professional development or the workshop, it was enough to give you an idea of how helpful it was going to be, and so I think we were all pretty excited about it.

> It's just, like I said, now trying to incorporate everything or change things to make it fit was the only issue.

BPCC staff overseeing the FITW initiative also incorporated training on the mobile apps into the professional development sessions held before the Fall 2017 semester. This training addressed concerns that faculty members had raised during the Spring 2017 intervention period, such as allowing instructors hands-on time using the apps, providing them with additional examples of how they could incorporate the apps into their instruction, and informing them earlier of which course sections would be assigned to the treatment and control groups so they could have additional time to prepare if their section was selected for implementation. This professional development session was well-received by the faculty.

In regard to the IDP, more than 75% of faculty and advising staff had received training on Inspire by the end of the third year of the grant. Responses to post-training surveys indicated that the vast majority of participants felt that the trainings were useful. In addition, participants in the training reported that the faculty members who led the training were highly effective. As one faculty member stated:

> [The faculty member leading the training] was very passionate. He was sold on it and I had the utmost respect for him, which gave me good cause to say, this is something that I need to zero in on a lot more…He convinced me of how it was meeting some good needs that we need to consider as a school.

Generating Student Buy-In

After the course sections had been randomized to the treatment and control groups, BPCC staff sent students enrolled in treatment sections an email notifying them of their ability to download a mobile app for the course in which they were enrolled. Students' email addresses served as their account name, and a default password had been set for them. The email explained that students would be prompted to reset their password during the first login.

In addition to this email, BPCC staff created a one-page handout that explained in detail how students could log on to the site, reset their password, and install a shortcut to the site as an app on their device. Faculty distributed these handouts immediately after students were notified via email that the apps were available. Students interviewed in focus groups recalled receiving these handouts and described them as helpful and informative.

After the initial communications with students, BPCC staff monitored individual students' usage of the apps to determine the percentage of students who were using them and the extent of their engagement. BPCC staff sent follow-up emails throughout the semester reminding them of the resource and encouraging them to use it. The first email was sent roughly five days after the first email, and additional emails were sent every 2-4 weeks thereafter. The mobile apps were also designed to send students positive feedback via email when they completed certain milestones, such as completing certain percentages of quizzes or videos.

Finally, BPCC staff overseeing FITW implementation scheduled in-person demonstrations of the apps in course sections assigned to the treatment group. The staff who conducted the demonstrations indicated that they were well received by both students and faculty. An instructor echoed this sentiment:

> I was very glad to have [a BPCC staff member visit the class]. [He] came over and helped students sign in, who I knew that there were a few who either had never signed in up to that point or had not signed in in a while. And so it was nice having him on hand.

Generating Faculty Buy-In

Although BPCC staff overseeing FITW implementation communicated directly with students via email to inform them of the opportunity to download the apps, they knew that students were less likely to use the apps without active support and encouragement from their instructors. However, they also recognized that implementation posed a number of potential challenges for faculty, such as having to quickly learn the new mobile app technology and incorporate the apps into their instruction.

In addition to the formal professional development session, BPCC staff identified a number of key faculty members in each department that were highly regarded by their colleagues to serve as the liaisons between project staff and the faculty. These faculty liaisons facilitated many of the professional development sessions and provided one-on-one coaching with other faculty using the apps. It appears that this strategy has proven effective at increasing buy-in for the initiative, as many instructors view the initiative as faculty-led rather than a top-down mandate from central administration.

Finally, BPCC staff have discussed plans for creating short modules or webinars designed to explain to faculty how the apps work and how they can incorporate the apps into their lesson plans and course assignments. These modules would be co-created by faculty liaisons and BPCC staff directing the project. Additionally, these modules would explain to faculty the cognitive science principles underlying the apps, such as the benefits of information recall for cementing long-term learning and the "flipped classroom" approach to instruction.

Advising Staff's Perceptions of IDP

The majority of advising staff spoke highly of the usefulness of the Inspire tool. There were three key benefits mentioned by multiple advisors who participated in interviews. The first benefit was the ability to see all the interactions a student has had with different offices, divisions, and personnel at BPCC. This documented history of interactions allows advisors to "pick up where the last person left off," as one advisor described it.

The second benefit mentioned by advisors was having a record of advisors' interactions with students to address miscommunications. An advisor told a story of a student expressing frustration that her financial aid would not apply to her courses. The advisor did not recall the interaction until she reviewed their interactions and realized the student had requested to change her major. When the advisor asked the student if they had submitted the change of major form she had provided, the student said no. The advisor was able to explain that was the reason why the students' financial aid was not being applied to the courses she was enrolled in. Given the significant number of students BPCC staff often advise, a number of advisors mentioned the benefits of having interactions with students documented.

The third benefit was the ability to target select groups of students for outreach or interventions based on filters chosen by advisors. For example, one advisor described using Inspire to identify students who had been admitted to BPCC but had not yet registered for Fall classes. Advisors pulled the list of students who fit this description and used Inspire to send students a personalized email encouraging them to register for courses. Overall, all front-line advising staff interviewed expressed satisfaction with the Inspire tool.

Faculty Response to Intervention

Initial Excitement with Mobile Apps

The desktop version of *Open Campus* had been in existence for many years before BPCC began developing the mobile app versions. A few instructors reported that they were unfamiliar with the resource before the intervention began this semester, but the majority were aware of the tool. Both English and math instructors also reported incorporating *Open Campus* videos in their instruction in

various ways, with some even requiring students to watch the videos in order to receive points toward their grade.

Despite the familiarity with *Open Campus*, the majority of instructors expressed genuine enthusiasm for the idea of providing students with mobile apps that allow them to access curricular content anytime, anywhere. This quotation from one instructor summarizes the general perception among the faculty:

> I think most of us, even the ones who didn't get chosen for [the treatment group], are interested in it, especially when we had the workshop. Everybody was very excited about it and that it was going to be available to the students. If the students can access something pretty easily, by just that app, they will go on it a lot quicker than having to go through a long list of things. I think the easier it is for them to access, the more they'll use it.

Benefits of the mobile apps were expressed even by instructors who were heavily reliant on the desktop version of *Open Campus* and were somewhat reluctant to abandon their current practice in favor of using the apps. One such instructor stated:

> I think the biggest difference that would [make me] want to really encourage the app is the chunking of the videos. Like you can go and watch the homework video, and it's like how long, and you've got to fast forward if you need. Whereas if they have the app, you can click that exact objective and spend two to three minutes learning about that objective, the only one you needed.

In short, even though aspects of the implementation of the apps posed some challenges for faculty, the consensus seemed to be that instructors were enthusiastic about the prospects of providing students with mobile apps and using them in their instruction.

Confusion Over Website Version of Mobile App

Whereas there was genuine excitement expressed about the mobile apps, there was also confusion amongst faculty and students over the format of the apps. As discussed above, the first phase of the apps consisted of developing a new website for *Open Campus* built using a responsive design compatible with mobile devices. Although installing a shortcut to the site on one's phone resulted in the site resembling and functioning as an app, the non-traditional installation process was a source of consternation for some. As one instructor described:

> The first time, when they talked about how they were developing this app, I was going into the App Store, and I was like, "I've been looking for this thing. Where is it?" And in my instructional meeting they were like, "Oh it's not an app yet. No, it's just in development. It's just through a website."

Even when faculty members handed out the instructions for accessing and installing the mobile apps created by BPCC staff, students were also confused about the version of *Open Campus* they were supposed to use.

One instructor stated that many of her students had reporting using the app, but when she received her student engagement report it did not show these students as having ever logged into the system. She eventually learned that students had searched for BPCC's *Open Campus* on the internet after misplacing the handout and had likely been using the older desktop version of *Open Campus*.

Although students may have benefited from the resource, there was no way for the instructor to track her students' engagement with the platform. Some students found the correct site, but only accessed it through a computer and never installed in on their phones.

The results of the interviews and focus groups suggest confusion will likely be reduced, and perhaps use of the apps increased, once they become available through the App Store or Google Play. As one instructor argued:

> I think once it's an actual mobile application they can download in the mobile app store, I think that's different than ... I see something and I'm like, "Oh it's just a website, I'm saving it as a thing on my phone." To me that's not the same as a mobile application…I think once it's a mobile application everyone can download, I think that more [students] will be more inclined to use it.

Randomized Controlled Trial Process

A critical component of BPCC's evaluation is the process of randomly assigning course sections to receive access to the mobile apps or not. Although this methodological approach is designed to produce rigorous evidence of the impact of the intervention, the process was unfamiliar and challenging for faculty. There were three key concerns related to the evaluation design that emerged during conversations with faculty. The first was being selected for the control group and not being able to use the apps at all. Many instructors were excited about the possibility of incorporating the mobile apps into their instruction when they heard that BPCC had been awarded a grant from the FITW program to implement the apps. One math instructor stated:

> I was real excited…they told us we would get an email letting us know if we were going to be chosen or not, so I was like, "God, I hope I'm chosen." I knew I taught two classes, so I said, "Well at least maybe one of my classes will be chosen," because I was real excited as soon as I got back to the school with the information, I started going through it and taking quizzes and watching videos. Oh yeah.

Although this instructor was selected for the treatment group, instructors who were not given access to the apps expressed frustrations. Some faculty who helped to produce the new video lectures for the mobile apps were selected for the control group. Although instructors were disappointed, they did express understanding of the reasons behind the evaluation design. The role BPCC staff played in communicating the purpose of the evaluation was key in maintaining buy-in among faculty, particularly those in the control group.

The second concern was the timing of the course randomization. In order to minimize incidences of attrition and contamination (i.e. students assigned to the control group changing courses and getting access to the mobile apps, or vice versa), the third-party evaluator recommended that course sections be randomized to the treatment and control groups after the last day for students to modify their course registrations during the Spring 2017 semester (January 20, 2017).

This meant instructors were not notified of which group they were in until roughly two weeks after courses had begun. Some instructors indicated that their course schedules were highly structured, making it difficult to modify the schedule in order to explain the apps during class time and incorporate them into instruction. For example, when asked about students' use of the mobile apps, one instructor stated, "I don't have any assignments geared toward they have to go on there because I had already designed my class prior to [being assigned to the treatment group]." Another instructor reported:

> Once we start teaching, we don't have time to stop a class and for 30 minutes take a trip to the [computer lab]…I mean and so we introduced it, what, two or three weeks into the semester? Well we're on a roll and we have notes to get done. We told them about it, we handed the handout, we encouraged it but, I'm with you. I think it would have been different if we on day one, as part of our housekeeping stuff, could have all done it together. That way everybody knew how to do it.

Throughout the Spring 2017 site visit, multiple faculty members reported that more advanced notice of which group their course sections were in would have increased their implementation of the apps. As one instructor stated, "By the time we got the app going and everything, the semester was way in before I even found out that I was in [the treatment group]."

This feedback from instructors contributed to the decision to randomize course sections earlier in the semester for the Fall 2017 intervention. Faculty reported being much more satisfied with the timing of the randomization and when they were notified of their assignment to the treatment or control group for the Fall 2017 semester. One instructor summarized how more advanced noticed of the assignments contributed to her ability to more effectively integrate the apps into her instruction:

> Yeah, so I think last semester what happened was that we didn't know…which classes of ours, or if at all, our classes were going to be chosen to do this. I had already made my lesson plans, and I stick to my…I'm pretty structured with how I have every day planned out, so it was just hard for me to like work stuff in like that after I had already made the plan, because I think it was like two or three weeks into the semester maybe. So this semester we knew ahead of time, and so I actually had three or four different days scheduled where I was working in some of that material as either supplement or just part of the lesson. That helped me out as just a logistical thing. I probably altered five or six of the lessons that I would normally have taught.

The third concern was confusion over the role of instructors in encouraging students to use the apps. Although some faculty members in the treatment group may have simply elected not to use the apps, others expressed confusion over the extent to which instructors should emphasize use of the apps. Three different instructors expressed similar confusion:

> Well, for me, all I did that first week was show it to them. I passed out the handout, this handout, which I thought was really well done. I thought, and I didn't have any students coming to me complaining that they couldn't follow the handout. Then I actually put it up on the projector and walked them through logging in and then I showed them what the class looked like and they all acted interested, but then I didn't really push it again. Because my plan was to use it to reinforce skills before exams.

> I guess maybe I was a little confused about the nature of the study. I kind of assumed it was just a monitoring to see what they did with it. I wasn't promoting it so much…Yeah because when we were presented the app, it was, "You don't need to change anything." I got the impression that it was, I mean it is voluntary obviously but to just leave it alone. Maybe that's what y'all were measuring. I didn't know.

> I think that we've got to figure out a way to incorporate it into our course calendar somehow to get [students] involved so that we see that it actually works, because with the way it's set up now, we don't have to change what we had already planned, so therefore, here it is. It's available to you but it's up to you whether you go on it or not.

The lack of advance notice regarding which course sections would be granted access to the apps and confusion over the extent to which faculty were supposed to encourage use of the apps both contributed to relatively limited implementation early in the semester. One instructor candidly stated:

> As far as working it into my class as supplemental material, I haven't done that. I have failed to do that. I do plan to use it more. I just haven't.

Alignment with Pre-Existing Courses

One potential obstacle to instructors' ability to seamlessly integrate the mobile apps into their instruction was the degree of alignment between the course content available through the apps and instructors' pre-existing course schedules and syllabi. Despite this potential challenge, faculty members expressed high levels of satisfaction with the alignment between the content in the apps and the subjects they normally covered in the courses. When asked about how easy or difficult it was to integrate the apps into instruction, one faculty member stated:

> It was easy because everything they teach in the course is everything we're already doing. My lesson plans were laid out. I know exactly what was going to happen every day for the length of the semester, so I could just use the *Open Campus* as supplemental stuff for the students' use. It was easy to throw in.

This conversation between a different instructor and the evaluator surfaced similar reactions to the alignment with the instructor's course schedule:

> Evaluator: Did you feel like there was alignment between your lesson plans and your outline for the semester and what-
>
> Instructor: Oh yes.
>
> Evaluator: Yeah?
>
> Instructor: Yes, very much so. Very much so. I was really excited because that's why I went on real quick to see, does this line up with the things that I'm teaching? Man, it was bam, bam, bam.

Overall, no instructors reported that the topics they covered in their classes differed in any fundamental way with the topics included in the app modules. However, at times there were slight pedagogical differences, such as instructors in the video lectures explaining a concept one way and in-person instructors explaining the same concept in a different manner. Faculty members had mixed responses to this situation. Some felt that explaining things differently would increase the likelihood that students would understand the material, given that students think through the same problems using differing strategies:

> Well, she touches on different ways to do things, too, I think, in some instances, because there's some things that you can do more than one way. It seemed to me that she touched on that. Being a math teacher, I'm not one of those that says, "You must do it this way." I allow, there's numerous ways and kids think different. One sees it this way, and one sees it this way. You don't want to make him do the problem a certain way. If he totally gets it another way, don't put him in a box.

However, other instructors expressed concern that explaining things too differently could become a source of confusion, particularly given that students enrolled in developmental education courses often struggle academically:

> The only thing that I think is a little bit different is some of the videos, teachers will explain things in a way that I don't teach it, or another math teacher might show things a different way…I'm sure other teachers do other things, so I think that could be confusing for a student who's not strong in math, if they're getting instruction from a teacher one way, and then they're going and watching a video and it's teaching them a different way. That's not extremely helpful. I try to steer clear, and don't assign those videos when the teacher is doing something different than me.

Without complete uniformity in pedagogical approaches among instructors, it is inevitable that some differences will exist between how an in-person instructor teaches a topic and how it is explained in the pre-recorded video lectures available through *Open Campus*. Although this is neither inherently positive or negative, feedback from faculty suggest it would be appropriate to discuss how to effectively account for these different approaches when instructors are being trained on incorporating the apps into their instruction.

MyMathLab

One of most significant obstacles to the implementation of the mobile apps in the developmental math courses was BPCC's use of separate courseware technology called *MyMathLab,* a product of Pearson®. All math instructors at BPCC use *MyMathLab* in developmental courses to assign students homework and have them complete activities. At the request of math instructors, BPCC had integrated the *Open Campus* videos into the *MyMathLab* portal. In the two developmental math course numbers that were part of the intervention (Math 98 and 99), students were required to at least click on the videos through *MyMathLab* in order to receive points toward their grade. One instructor described the process for students:

> When they go to open up an assignment for that day's lesson, the video, it's listed as a homework problem. They have to click on the video to get a point for that homework problem. They don't have to watch it, but it just was the easiest way for us to put it into the assignments to where they didn't have to hunt for, you know, "I didn't understand the lesson today, where can I find that video?" They go to that homework, there's a video if they need it. If they don't need it, we tell them, "Just click on it and click off, but that way you know where it's at."

Because math instructors were committed to using *MyMathLab* in their instruction, many felt it to be counterintuitive to request that students watch videos through the mobile app instead of *MyMathLab.* As one math instructor stated, "The videos are already in their homework, so why hunt for them when you can just click on it?"

During the focus group with math faculty, some instructors in the Spring 2017 site visit suggested that the *Open Campus* videos should be removed from *MyMathLab* for both treatment and control groups. The control group would still be able to access the *Open Campus* videos through the desktop site, and the treatment group would get access to the mobile apps.

It was expected that this would encourage students in the treatment group to use the mobile apps without fundamentally changing the educational experience of students in the "business as usual" condition. This change was implemented in the Fall 2017 semester. Although some math instructors were displeased with this decision, most recognized that this approach would allow BPCC to collect stronger evidence of the efficacy of the mobile apps on student performance.

Technical Difficulties with Mobile Apps

In general, the response from faculty to the core components of the mobile apps was quite positive. However, faculty members did report a number of technical difficulties using the mobile apps. The following conversation between the third-party evaluator and a math instructor highlights these challenges.

Evaluator: So how is it going so far? The implementation of the mobile apps?

Instructor: Just okay.

Evaluator: Just okay?

Instructor:	Yeah. There were a lot of issues with them submitting quizzes, and it wasn't giving scores back.
Evaluator:	Is that why they're having to take screenshots?
Instructor:	No. They have to take screenshots because I don't have access to their stuff.
Evaluator:	Oh, really?
Instructor:	Yeah. I don't get to see what they do unless they physically show me what they did. They either have to show me in person, live, or take a screenshot and send it to me, so that's that, and there's glitches in the system. It's new, so that's going to be normal, but all the videos, I think were fine. It was just taking the quizzes and stuff.

These concerns were echoed by other faculty members in both the Spring 2017 and Fall 2017 semesters. Instructors also reported that response options for quiz questions were incorrect. For example, different response choices would have the same answer (e.g. A = 40, B = 42, C = 42, etc.) or the question stem would ask for the value of X but the response options would contain values for Y. Although relatively minor, these issues were bothersome enough to be mentioned by instructors in multiple interviews and focus groups. These concerns have been relayed to BPCC staff designing the apps and have been addressed as they have been identified.

Lack of Oversight Functionality

In the Phase 1 version of the apps, faculty were not able to log in to the system and track their students' progress, nor did they receive any type of automatic notification when students completed tasks within the app. This proved a challenge for faculty who required students to engage with the apps in specific ways. For example, some faculty required students to watch videos through the app. The only way students were able to submit evidence that they had completed this task is by taking a screenshot with their phone of the completion window that popped up once they had finished viewing the video.

Faculty reported that BPCC staff overseeing the implementation of the apps would send them weekly reports with some information on students' engagement with the apps, such as which students had logged in, the last time they logged in, and the number of videos they had watched. However, key pieces of information, such as which specific videos students had viewed and their grades on quizzes, were not included in these reports. Some faculty reported not receiving this information until about one month into the semester. For faculty teaching eight-week courses, this provided limited time for them respond to the information about student engagement. Other instructors reported receiving the reports but not reviewing them.

For the apps to be even more useful, faculty requested that the apps include an electronic gradebook that would allow the faculty to assign specific videos and quizzes to students and factor only these assignment tasks into grading, assign weights to videos and quizzes in according with their grading policy, and automatically calculate student grades so that faculty would not have to do manual calculations. These features are planned to be incorporated into Phase 2 of the apps that will be released in Spring 2019.

Continued Variation in Instructors' Use of the Apps

Instructors had limited time to integrate the mobile apps into their courses for the Spring 2017 semester, both due to their unfamiliarity with the apps and the timing of the randomization. At least some instructors were able to more fully integrate the apps into their courses during the Fall 2017 intervention. Multiple instructors mentioned requiring students to complete quizzes and watch videos within the apps as part of their homework. One instructor required students to take the quiz but only graded them on

their completion of the quiz rather than the percentage they answered correctly. "I made [the quizzes] worth points for their homework assignments, regardless of whether they got them right or wrong. It didn't matter," she stated. "But what I did notice was that they were ... I had more students, this time, repeat the test to try to get it right, as opposed to just blowing it off. I like that." Another instructor provided a similar account.

> I'm requiring them to take the test, at the end of the module. I've given them dates that they're due. I've coordinated that with what I'm teaching, obviously. It's worked out well. I've asked them specifically, "Did this help you? Do you feel as though you came to class better prepared and sort of knowing what I'm going to do?" Several of them said, "Yes." They did. So, I was glad to hear that.

Other instructors had students complete the quizzes in class as a way to practice concepts that the instructor recently covered through lecturing. Rather than a traditional quiz, where students only get to attempt it once and are graded for the percentage they get correct, this instructor required them to take the quiz repeatedly until they received a perfect score. Importantly, he did not use this approach in the Spring 2017 semester but did so in the Fall 2017 semester, reflecting his continued experimentation with how best to use the apps. He described the process in the following manner:

> I had been using it in my class really as like bonus opportunity [in the Spring 2017 semester]. I would make it a suggestion, but I didn't necessarily incorporate into the class. But, I still had some pretty good results at the end of the semester, especially in the students who I could go back and see had used it, their grades were demonstrably higher. So that was encouraging.
>
> So this time, I brought the pilot class to the writing lab, which is our computer lab on the second floor, and had them all log into *Open Campus* and I had them do the quizzes in two of the modules that corresponded with the midterm and I told them to take them until they made a hundred. Watching them, they got into it. I could see some of them were getting into it almost like it was a game, which that is what we want. Cause if they'd score a 90, it's like, "Oh! I got a 90, it's so close!" And then they'd just dive right back in there, do it again.

Yet other instructors used the apps quite differently, and at times in ways that may have been counterproductive. A key principle of the apps is that providing students with modularized videos allows them to re-watch concepts that they may have struggled with in class and to do so at their own pace. This "flipped classroom" approach would therefore consist of students watching videos on a topic either before or after that topic was covered in class. In contrast, at least one instructor mentioned instructing students to watch the videos during class time. Expectedly, he encountered difficulties with this approach. "Sometimes it's not easy to incorporate [the apps] into the class," he stated, "only because you're watching videos on your phone, so having 25+ people watching separate videos just doesn't work."

The majority of instructors reported that requiring students to use the apps in some manner, whether by assigning videos for homework or making students complete the quizzes, was more effective than simply mentioning the apps as a supplemental resource. However, faculty also reported that some students either had technical difficulties using the apps or did not have a smart phone, which would prevent students from using the apps altogether. For this reason some instructors indicated they were wary to make use of the apps a required part of the course, as that could unfairly disadvantage students for whom accessing the apps was a challenge.

Faculty Use of the Apps to Improve Their Own Instruction

Although the apps were not specifically designed for this purpose, instructors in both the Spring 2017 and Fall 2017 semesters reported watching the videos in the apps to see how their colleagues teach specific concepts in order to improve their own instruction. One instructor gave this account:

> As a matter of fact, I go on [the apps] and watch. I try to. I try to watch the videos…I did some of them, on the plane on the way home [from a trip]. I try to follow [the instructor in the video's] lead…so that it would be consistent, because we're teaching the same thing. So, there would be consistency for the student. That does matter.

Instructors' Positive Reactions to IDP

Despite some ambivalence, many instructors recognized the value of a tool such as Inspire. One instructor described the course registration process as "complicated for students and for faculty. It's chaotic." Any tool, including Inspire, viewed as potentially alleviating that confusion was welcomed. Inspire was viewed by some as particularly important given that both faculty and advisors are tasked with assisting students with course registration and students receive advice from many other departments and divisions on campus. As one instructor stated:

> If [a student is] in your particular division, you're talking with your advisor for that particular major. Then you come over here to advising and you talk to a different advisor, then we can see what's going on in relationship between that interaction that you had with person A and the interaction I should be having with you versus me starting just totally from a blank state, even though you've seen three different people. That's the best thing because now I've had, even when we're doing some of the training, I've had it where some instructors say, well that's what I do. I actually write down information when I advise my students and stuff.
>
> I say, that's great! That is wonderful. You should do that, but if you're the only one that is advising that student then that's going to work out perfect. But if somebody else advises that student, they don't have access to that information that you have. Now we have a device where you can put that information about what took place with that student as far as advising that student on his academic progress. And everyone has that information versus I have it here and that student is only going to come to me and get advice. That's just not realistic. It's not.

Some instructors similarly felt that having a single source of information about students' interactions with various departments, offices, and personnel across the college was extremely useful. As one instructor stated:

> I like the notes of Inspire, because as a teacher, I can't tell you how many times, after we've been into the semester, I have to figure out, "How did you get in to this class? You're not even…You haven't even met the prerequisites. Who put you in here?" And with that, being able to leave a note, "So and so got special permission from this instructor to be put in the class, even though it was closed," because sometimes that happens. But there's nothing for us to look at to see how this situation happened. So I like the note side of [Inspire].

Perhaps most importantly, instructors felt that Inspire was a tool that could empower faculty, help them more effectively serve their students, and ensure their advice to students was heeded by others on campus:

> We need to know more. The left hand needs to know more what the right hand is doing. I'll put it that way. If I talk to somebody then another faculty member comes and visits with that student six months from now, I don't want the things that I said ignored. I don't. Especially, and a matter of fact I'm very adamant about it, if it's a student [in my program], I really want to talk to that student myself or somebody in the program. That cannot always be done, especially these new

> students. I want our students to have very directed advising…I want others to know it's serious to me. My job is serious. It's more than just advising.

Instructors' Negative Reactions to IDP

There were two factors that tended to result in BPCC faculty reacting negatively to the tool, at times quite vehemently. The first was the perception that reforms tend to come and go at BPCC, and possibly in higher education more generally, that made people skeptical of any new reform that requires time and effort from instructors. One faculty member described his initial response to hearing about the purported benefits of Inspire: "You get skeptical after twenty years and everything so you're like okay, yeah, right."

The other factor causing resistance to Inspire from faculty was a general resentment toward being required to advise students. A majority of instructors interviewed during the site visit felt that the requirement from BPCC administration for instructors to advise students during specific registration times during the semester detracted from their teaching, was outside of their proper role as instructors, and was something they were not properly compensated for. This sentiment colored instructors' perceptions of Inspire. As one instructor described her reaction to Inspire:

> I don't care. I don't…I hate to advise. I'm a teacher. I'm a therapist. I don't want to advise. I think it's probably a great plan. It's a great project. It's a great this. It's a great that. It's just another annoyance to faculty…I doubt any of us will do it. If we do, it's going to be begrudgingly, because we don't have the time to pull this up, and pull that up, and do this, and do that, and all these fabulous ideas are great, but nobody's making any more time for us. Nor is anyone offering us any more money, in eleven years. So, let's just throw that in there…We cannot do one more free thing…[Inspire] is a thorn in my side.

A different instructor shared similar sentiments:

> I'm not a fan [of Inspire] at all. But it has less to do with it and more to do with we don't want to do that. And I went to the introduction thing, I said, "Oh, this is great. It's more work for me." And that's no problem other than that is in my contract, I get that, but I still don't like it. And [Inspire] is…it's more entailed. And I won't do it. So, there you go.

Even when instructors were not as vehemently opposed to the use of Inspire as the instructors quoted above, they often felt that the tool would be of limited value given how infrequently they are required to advise:

> In the advising center, they do this all semester long. I do it one week out of the semester. And for the first couple of students, I really, I have to relearn how to do it over again. And that's just using, you know, the other stuff [such as the course registration system]. I just don't it often enough to feel like I have a mastery of it. And so I worry that the first time I go into Inspire… I'm going to have to learn it all over again.

Similarly, whereas instructors felt capable of advising students about the required courses to take in majors in the department where the instructor taught, students would often come with far more complicated questions, particularly those related to the transferability of courses. One instructor mentioned advising students with these questions, and the interviewer asked her if she felt she should be providing this type of advising. The instructor responded:

> In theory, no, I should not be. And I told [the student], I was like, "I can only put you in stuff…If you think this is going to transfer, then you need to go see an actual advisor in the advising center and have them do a degree audit," because I didn't even know where to start with

> that. I would feel confident making a math decision, but even then, these [courses] were from ten years ago, and how do I find her transcript from ten years and then the course description from ten years ago? That to me, that's too much for somebody who is not an advisor. I'm a math teacher who advises on the side.

Given some instructors' negative perceptions to advising overall, it will likely require a significant shift in these instructors' thinking for them to support BPCC's adoption of Inspire and use it themselves. As one instructor advocating for Inspire stated, "We have to get into the mindset that it's not something that's a burden on us, but it's something that's there to help alleviate a lot of the issues that we have."

Advisors were similarly concerned about faculty members' unwillingness to use Inspire, as that would severely limit the usefulness of the tool and result in advisors having less information about students' interactions with instructors. One advisor expressed these concerns while restraining her criticism of the faculty:

> We would have to convince the faculty to do input [in Inspire] or to have somebody that they could contact or send the students to as soon as the students start having…We have a wonderful faculty. There's a lot of faculties [sic] that help the students tremendously, but as soon as they get into unique type of difficulty, it's like any place else. We have faculty who are not as willing to work with students. They're there to teach. That's it.

Mixed Reactions from Faculty to IDP

Although Inspire had strong advocates and fierce critics among the faculty, the instructor interviews suggested that the most common reaction was mixed. Many faculty felt that Inspire could be a very valuable tool, particularly if other advisors on campus were diligent in documenting their interactions with students that faculty could then see in students' profiles. However, the most significant challenge for faculty was the additional time it takes to input their notes from student advising sessions into Inspire. The following response from one faculty member was typical of this sentiment:

> My initial impressions would be, it would be a wonderful tool that could help us. My later impressions are I wish we had more time to use it to the best of its benefits…I think the day before yesterday maybe we saw a total of 20 people. Yesterday we saw 60 some odd. There gets to be a lot of students waiting outside. If a student is just a brand new student that needs new information, I do not turn to [Inspire]. Where I try to turn to it, and maybe I don't turn to it enough, is when students are having problems. So, if we have the time to do it…that's been one holdup on my part, is finding the time to really do it the way it should be done.

Instructors and advisors' perception of having limited time to conduct advising was also exacerbated by the fact that both instructors and advisors reported using alternative methods for taking notes regarding advising sessions.

One instructor mentioned recording interactions with students in a spreadsheet. Although he admitted that Inspire was far more beneficial in that he could see the students' interactions with other people on campus and he did not have to go back through spreadsheets, his department had not yet abandoned the old practice of using spreadsheets to notate advising sessions. Until advisors and faculty members in similar situations decide to discontinue the use of old methods for documenting advising sessions, using Inspire will duplicate the work needed to record their notes. This may limit adoption of Inspire even in instances where instructors and advisors recognize the benefits of Inspire.

Non-Implementation of Components of IDP

Although BPCC experienced some challenges in generating buy-in for Inspire, particularly among faculty, implementation of the tool has been largely successful—the tool itself is fully functional, the majority of instructors and staff had received training on Inspire by the end of the third grant year, and use of the tool was growing rapidly across BPCC. Inspire is the only component of the IDP that was planned to be supported by grant funds. However, BPCC intended to implement two other components of the IDP created by Civitas, the Illume and Illume Impact tools.

The base Illume package integrates data from multiple sources together and uses algorithms to identify student experiences most related to student outcomes, and the Illume Impact tool allows users to estimate the impact of an intervention by matching students who received an intervention to a control group. The long-term vision is for BPCC to integrate data from the mobile apps into the IDP in order to assess how students' use of the mobile apps influences their persistence and attainment and study the effect of developmental education interventions on student outcomes.

A number of technical challenges have plagued the implementation of Illume and Illume Impact. The most notable was the Louisiana Community and Technical College System's (LCTCS) requirement for all community colleges in the system to use the Banner learning management system. BPCC's transition to Banner seems to have impeded their ability to prioritize implementation of Illume and Illume Impact. Similarly, Civitas represented to BPCC that connecting Illume to BPCC's data systems would be relatively straightforward, yet Civitas also appears to have underestimated the complexity of the task.

These technical difficulties resulted in discrepancies and inaccuracies in the data reported in Illume, which subsequently sapped support for the tool. As one administrator noted:

> In almost all the trainings [on Illume] that we had, it came up almost every time that the data wasn't being pulled accurately. A lot of people were saying, "Why would I use this if I'm not getting accurate information anyway?" So they just kind of quit using it or quit even looking at it because they thought it's not pulling [data] accurately.

BPCC staff instrumental in the FITW initiative continue to believe that the ability to integrate data from the mobile apps into the IDP would be extremely beneficial, particularly when considering how to evaluate developmental education interventions. However, Illume and Illume Impact fall outside the scope of their purview given that grant funds were not used to cover the costs of those tools. It remains to be seen whether BPCC will be able to implement those components of the IDP in the final year of the grant or beyond.

Student Use of Mobile Apps

Initial Access to the Apps

Due to the randomized controlled trial approach to the evaluation, BPCC had to ensure that only students who were enrolled in one of the course sections assigned to the treatment group at the time of randomization received access to the apps. To do this, BPCC pulled lists of students' email addresses and sent them individualized emails with information about how to access and download the apps.

Students were provided a login account and were instructed to reset their passwords the first time they logged into the system. In addition to these emails, instructors of course sections assigned to the treatment group were provided a handout with instructions that they distributed to students in class. Some faculty took time in class to assist students with logging in and downloading the apps, although it is unclear how pervasive this approach was across faculty.

Some faculty members expressed concerns that students would not respond to the emails, or the number of steps required to download the app would discourage them from doing so:

> Maybe if there's some way that we could've actually signed the kids up instead of them having to go on and say, "I forgot my password," and they had to create their own password. If there was a way that we knew their student ID and we could say, "Here's the website, here's your username, here's your password." With college kids, from the time I give them the paper, by the time they get home, they may not even still have that paper that tells them how to do it.

This theme also emerged in student focus groups.

Evaluator: Do you remember when you first heard about this specific app ... For the two of you that were in this class [in the treatment group]. Do you remember how it was described? What's the purpose that you're doing this? Do you remember?

Student 1: I just seen the email.

Evaluator: You don't remember hearing anything about it in class? You just got an email basically saying-

Student 1: Yeah, I remember it, but I don't remember what he said.

Student 2: I know there's a grant or something I got.

Evaluator: …Was this the first time that you basically had an opportunity to download an app [for a class]? What did you think?

Student 2: Awesome.

Evaluator: Yeah? You thought awesome? That was your first impression?

Student 2: Yeah, I liked that.

Evaluator: [gesturing to Student 1] What about you?

Student 1: I didn't really think nothing of it.

Evaluator: Yeah?

Student 1: Because I didn't really open it.

The Spring 2017 site visit was conducted relatively early in the semester, and at a time when there was still confusion among the faculty about how extensively they should incorporate the apps into their instruction. For these reasons it is not entirely surprising that some students did not fully embrace the apps immediately after being granted access to them during the Spring 2017 intervention.

Some instructors tried different approaches in the Fall 2017 semester. One instructor recounted approaches that her colleagues had used:

> I think in some of the classes that have the computer labs, I think they had the whole class log in for the first time together. And I think, once they had an account, and it was there, they would probably be more apt to use it. But in a regular classroom where I just told them about it and I didn't make it a requirement, I don't think they have the motivation to go do that on their own.

Engagement with the Mobile Apps

Student engagement with the mobile apps was limited early in both the Spring 2017 and Fall 2017 semesters. Multiple instructors reported that they had no students logging into the system at the time the first student engagement report was disseminated to faculty in the spring, even when they walked students through the login process in-class. Indeed, low student engagement was a primary reason the Spring 2017 site visit originally scheduled for the end of the semester was conducted in February instead.

As discussed above, many faculty members did not emphasize the apps much early in the semester, and if they did they used the app courseware as a supplementary resource rather than as an integral part of work for the class. This is a likely cause of low student engagement with the apps early in the semester. As one instructor stated:

> Most of our students, if they don't see some kind of reward, most of them aren't going to [make the effort]. You're going to have the overachievers who, if it's going to benefit them any kind of way, they will go on there, but the other ones are waiting for, "What do I get if I go on there and do this?" They don't think as, "How's it going benefit me? How is it going help me prepare? How's it going help me to become a better writer?" and so on. Most of them don't have that mindset. You have to kind of push them…some of the other ones, you have to kind of nudge them, so I think we've got to figure out a way to get them in there to actually use it.

After the site visit in late February 2017, it appears that instructors made a more concerted effort to emphasize use of the apps with students and engagement with the apps increased. However, engagement declined again towards the end of the Spring 2017 semester, despite the utility of the apps for allowing students to improve in areas where they struggled during the semester and prepare for their final exams. These patterns were similar for the Fall 2017 cohort. Overall, about one-fifth of students assigned to the treatment group in both the Spring 2017 and Fall 2017 semesters accessed the mobile apps and watched at least one video, although a higher percentage of students utilized some version of *Open Campus* if the students who accidentally used the older desktop version are included.

Although students did report technical glitches with the apps, even students who expressed concerns often engaged with the apps in desirable ways. One student gave this description when asked about how she used the app:

Student:	I go on there, I look at the video and I'm like, "Oh, okay. That makes sense," and then some of the questions I was like, "I don't understand this."
Evaluator:	For the quizzes you're saying?
Student:	Yeah.
Evaluator:	You like the videos, but the quiz is still…you weren't totally sure?
Student:	Yeah, it took me forever to finally get a good grade. Retry, retry, retry.
Evaluator:	Did that process help you figure out which ones were wrong or not? Like taking the quizzes multiple times?
Student:	Yeah.
Evaluator:	Do you feel like that helped you retain the information or were you just like, "I'm going to just keep pressing options until I get the grade," but you're not really retaining the information?
Student:	I was working it out. I would look at the problem like, "Which one did I miss." Sometimes they wouldn't even show up on the same quiz. I was like, "Okay, I see how I do this."

Overall, students who engaged with the apps in any substantive manner reported high levels of satisfaction with their functionality and engaged with the apps in ways that literature suggests will lead to improved retention of information and performance in courses. The key concern for BPCC moving forward is strategizing ways to increase student engagement with the apps and addressing any technical

issues that arise which could lead to students being turned off by the apps before they realize the benefits of using them.

Characteristics of Students Who Use and Do Not Use the Apps

The mobile apps are designed for all students enrolled in one of the targeted developmental education courses, but instructors described how student characteristics might influence whether or not students choose to use the apps. On one hand, students who were performing very well in the course may be disinclined to invest additional time in a supplemental resource like the mobile apps, particularly if use of the apps was not a required component of the course. This concern was discussed by one instructor:

> I have a group of 26 in here and I happen to have a very good smart group that obviously has had algebra 2 before so they're just refreshing themselves. So my first two quizzes I had a lot of A's and a lot of B's so hence I don't have very many feeling the need to get on the app for remediation.

On the other hand, multiple instructors reported finding that students who needed support the most were often the least likely to use the apps. As one instructor stated:

> Some have said so far that the issue with making it optional is that the students who need it the least are the most likely to do it, and the students who need it the most are the least likely to do it sometimes. If you make something optional then the kids who you really are like, "They could benefit from this," are the ones that aren't going to do it. So it's that challenge of creating that incentive.

Supplemental analyses not contained in this APR suggested that lower performing students were in fact more likely to use the apps among the sample of students assigned to the treatment group. However, it may be the case that lower achieving students are more likely to use the apps compared to very high achieving students, but very low achieving students may be the least motivated to use the apps.

Student Perceptions of the Mobile Apps

Among students who used the apps, perceptions of their functionality and ease of use were mixed. Some students reported no technical issues and tremendous benefits from using the apps. For example, one student who was interviewed recalled having no problem installing the app on her phone, felt that the mobile app courseware was perfectly aligned with what she covered in class, and had completed the majority of quizzes and videos in both of the developmental classes in which she was enrolled. This student described the app as an excellent resource: "It's pretty cool. The app is very great though. It is."

One of the key differences between the previous version of *Open Campus* and the mobile app versions was the modularization of the video lectures. Students reported high levels of satisfaction with the length and quality of the videos. However, students also reported that they did not initially realize that the quizzes covered entire modules whereas the videos covered sub-sections within the modules. For example, a particular module may have six or seven sub-sections with a different video on each, but the quiz would cover all of the sub-sections. Students began taking quizzes before watching all of the videos in a module, leading to them encountering questions for which they were not sufficiently prepared. However, students appeared to learn this relatively quickly and adjust their strategies for engaging with the apps accordingly.

Unfortunately, the technical difficulties students experienced with the apps may have hindered their engagement with them. This conversation with one instructor highlighted how students responded to these technical difficulties.

Evaluator: Have you gotten any student feedback from their use of the apps?

Instructor: Yeah. They don't like it. They laughed about it because they said, "This quiz won't submit. I don't know what your problem is." Or, there would be a problem that the variable is y, but all the answer were x's, which was not right. There would be answers that were the same, so that was a little bit confusing for them. Is it B or is it D? It's the same, x to the nth. Just little things like that. They didn't like that. They need it to work smoothly, and so they need it to be concrete, and really correct, or else it just throws them off, or they just laugh about it and move on, or they do that kind of thing. It's just been okay, as far as the quizzes go. The videos are fine. Videos are great.

Evaluator: If the apps were completely optional, where you didn't require them to watch the videos on the apps, or do anything on the apps, how much do you think they'd be using the app right now?

Instructor: Zero.

Although students did encounter some issues in using the apps, the overall student response to the apps was positive. In a student survey administered to students in the treatment group classrooms at the end of the semester, the vast majority of students said they were somewhat satisfied or very satisfied with the apps and agreed or strongly agreed with the statement: "Using the mobile app helped me learn the material covered in the class." Additionally, more than 90% of students who used one of the apps and responded to the survey said they would recommend the apps to a friend. These findings are tentative, however, as the response rate to the survey was quite low.

Faculty were sensitive to students' perceptions of the apps. When asked what factors would most strongly influence instructors' use of the apps in the classroom, numerous faculty mentioned students' responses to the apps as being a primary determinant. Thus, buy-in from faculty and students are mutually reinforcing – students are less likely to use the apps if faculty don't support them and integrate them into their teaching, and faculty are less likely to promote the apps if they feel they do not resonate with students. It will be important for BPCC to continue soliciting feedback from students to ensure they are reporting positive experiences with the apps.

Greatest Barriers and Facilitators to Implementation

The previous sections presented a more granular description of how implementation of the mobile apps and IDP through the first three years of the grant. The purpose of this section is to summarize what appear to be the greatest barriers and facilitators to implementation.

Barriers

The first barrier was confusion among faculty over the nature of the project and their role in its implementation. Although not all faculty shared this perspective, a significant portion of the instructors interviewed reported that they believed their function was to introduce the mobile apps at the beginning of the semester and remind students occasionally about their availability. Some believed that emphasizing the mobile apps too much could somehow bias the results of the evaluation, despite the fact that the efficacy of the apps could not be determined without students using them. It does appear that the site visit aided in clearing up misunderstandings among faculty about the nature of the evaluation, as student usage of the apps increased after that point. BPCC also conducted additional professional development for faculty before the Fall 2017 semester in order to support their implementation of the apps.

The second barrier was the technical difficulties encountered with the app and Inspire. Such issues are to be expected when new technology is being developed and implemented, but nevertheless both faculty and students reported frustration with these challenges. The most frequent issues related to the apps reported by stakeholders were the inability for students to show they had completed a task in the mobile app without taking a screenshot, quizzes not submitting correctly, and answer choices in the quizzes containing errors which made it challenging for students to select the correct answer. These issues were relayed to the BPCC FITW team after the first semester and are being addressed in phase two of the mobile apps. Additionally, some faculty were not accustomed to using technological tools, such as mobile apps or platforms such as Inspire, much at all. As one instructor stated of these instructors, "Other faculty…insist on having the paper, writing all their grades down, checking role on paper. I think especially those faculty that are still insisting on having the paper logs, that's going to be where this would be an issue because they're not as adaptive to the changes." This unfamiliarity with technology led some faculty to shun Inspire altogether before utilizing it in any significant amount.

The third barrier was the timing of the implementation of the apps. Due to the decision to notify instructors of whether they had been granted access to the apps or not weeks into the semester, instructors felt that they would have to carve time out of their instruction in order to assist students in installing and utilizing the apps. Additionally, instructors had already finalized their syllabi at that point, making it difficult for them to modify their assignments or grade calculations after the apps had been implemented. These concerns raised by faculty led to the decision to notify instructors of their assignments earlier for the Fall 2017 intervention.

The fourth and final barrier, or perhaps challenge, to implementation was the delicate balance BPCC staff overseeing the FITW project had to play in supporting implementation. On one hand, these staff were highly sensitive to the needs and challenges of instructors and did not want the FITW initiative to be viewed as a top-down mandate. On the other hand, both the mobile apps and Inspire could only be effective if instructors actually used them, and many instructors did not have much interest in doing so. Instructors themselves expressed competing views on the role that BPCC administrators should play in promoting implementation. Whereas some faculty members wanted to protect their autonomy in choosing whether to use specific resources recommended by the college, other instructors felt that use of the mobile apps and Inspire should be a requirement. BPCC staff overseeing FITW have used a variety of effective strategies to promote implementation without mandating use, but this tension between instructor autonomy and institutional mandate appears likely to persist.

Facilitators

The first facilitator was the support of lead faculty within both the English and math departments. FITW staff at BPCC recognized that faculty buy-in was critical to the successful implementation of the mobile apps and IDP, and the most effective strategy BPCC used to increase faculty buy-in was enlisting the input and support of lead faculty who were esteemed by their colleagues. These faculty were instrumental in designing the mobile apps, administering professional development to train other faculty in using the apps, and in incorporating the IDP into their practice. This resulted in faculty viewing the FITW initiative as faculty-driven rather than a top-down mandate from central administration. The continued support of lead faculty will be key to the future success of the initiative.

The second facilitator was the materials BPCC staff distributed to students and faculty explaining the initiative and the in-class demonstrations of the product they conducted. Although FITW staff at BPCC had presented on the mobile apps in some classrooms early in the semester, when they realized that student use of the mobile apps was lower than anticipated they made a concerted effort to visit all of the classrooms assigned to the treatment group in order to explain to students how to effectively use the

apps and address question and concerns that had arisen. This in-person approach appears to have been related to the increase in up-take later in the semester.

Finally, the last facilitator to implementation was the additional training and support of faculty as implementation proceeded. As discussed above, one of the most significant barriers that arose early in the semester was confusion over the nature of the evaluation and instructors' role in implementing the apps. Multiple instructors expressed misunderstandings about the extent to which they should emphasize the use of the apps to students and incorporate the apps into their instruction. In close collaboration with the third-party evaluator, FITW staff devised strategies for clearing up these misconceptions and encouraging instructors to utilize the apps without making instructors perceive the initiative as a top-down mandate they were being forced to implement. In multiple instances, the very same instructors who expressed misunderstandings during the site visit and whose students had not engaged with the mobile apps at all by early February had extremely high rates of student engagement by the end of the semester. This likely would not have occurred without the efforts of FITW staff to address these misconceptions.

IMPACT EVALUATION RESULTS

The impact evaluation for this fourth and final APR estimates the effect of the mobile apps on students' short- (developmental education performance), medium- (next semester persistence and performance), and long-term (degree attainment) outcomes for both Cohort 1 (Spring 2017) and Cohort 2 (Fall 2017). Estimates for Cohort 1 alone are found in the second APR, and estimates for Cohort 2 alone are found in the third APR. The research questions that guided the impact evaluation are as follows:

1) What is the effect of access to mobile apps on the rates of students passing one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    g. Does this effect vary by course number?
2) What is the effect of access to mobile apps on the grades students receive in the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    h. Does this effect vary by course number?
3) What is the effect of access to mobile apps on the semester-to-semester persistence of students enrolled in one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    i. Does this effect vary by course number?
4) What is the effect of access to mobile apps on the next semester GPA of students enrolled in one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    j. Does this effect vary by course number?
5) What is the effect of access to mobile apps on the overall course passing rates during the next semester of students enrolled in one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    k. Does this effect vary by course number?
6) What is the effect of access to mobile apps on the credits earned during the next semester of students enrolled in one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    l. Does this effect vary by course number?
7) What is the effect of access to mobile apps on the credential attainment rates of students who enrolled in one of the three targeted developmental education courses (English 99, Math 98, and Math 99)?
    a. Does this effect vary by course number?

Developmental Education Course Pass Rates

We begin by examining the rates at which the combined cohorts passed their developmental education courses. The results of the statistical model are found in Table 4. Across both courses and all course numbers, students in the treatment group were estimated to be 5.5 percentage points more likely to pass their developmental education course compared to students in the control group, a statistically significant difference ($p = 0.009$).

Table 4: Treatment Model of Developmental Education Course Pass Rates for Combined Cohorts, no Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.055	0.021	0.009	0.014	0.097
Credits Attempted Pre-Intervention	-0.014	0.001	0.000	-0.017	-0.011

Credits Earned Pre-Intervention	0.017	0.002	0.000	0.013	0.021
Race/Ethnicity (White)					
Black	-0.102	0.031	0.001	-0.163	-0.041
Other	-0.060	0.024	0.014	-0.108	-0.012
Female (Male)	0.102	0.022	0.000	0.059	0.146
Pell Received	0.000	0.000	0.000	0.000	0.000
Age Category (<18)					
18-21.99	-0.079	0.058	0.174	-0.193	0.035
22-24.99	-0.049	0.066	0.460	-0.179	0.081
25-29.99	0.039	0.065	0.546	-0.088	0.166
30-39.99	0.030	0.064	0.643	-0.096	0.156
40-49.99	-0.082	0.071	0.250	-0.221	0.057
50+	-0.109	0.093	0.238	-0.291	0.072
Block ID (Block 1)					
2	-0.001	0.097	0.993	-0.191	0.189
3	0.055	0.103	0.593	-0.147	0.257
4	-0.073	0.102	0.473	-0.274	0.127
5	-0.217	0.099	0.028	-0.410	-0.023
6	0.062	0.111	0.581	-0.157	0.280
7	-0.009	0.099	0.925	-0.204	0.185
8	-0.074	0.094	0.433	-0.258	0.111
9	-0.131	0.099	0.184	-0.324	0.062
10	-0.053	0.099	0.593	-0.247	0.141
11	-0.183	0.099	0.066	-0.377	0.012
12	-0.089	0.091	0.328	-0.268	0.089
13	0.009	0.116	0.938	-0.218	0.236
14	-0.037	0.097	0.700	-0.227	0.152
15	-0.062	0.095	0.513	-0.250	0.125
16	0.024	0.086	0.783	-0.144	0.192
17	0.141	0.114	0.218	-0.083	0.365

18	0.002	0.096	0.984	-0.186	0.190
19	-0.024	0.096	0.806	-0.212	0.165
20	-0.126	0.096	0.192	-0.314	0.063
21	-0.154	0.100	0.124	-0.351	0.042
22	-0.167	0.090	0.063	-0.343	0.009
23	-0.076	0.094	0.417	-0.261	0.108
24	-0.098	0.094	0.297	-0.283	0.086
25	-0.194	0.096	0.045	-0.383	-0.005
26	-0.293	0.103	0.005	-0.496	-0.090
27	-0.190	0.098	0.052	-0.382	0.002
28	-0.145	0.086	0.093	-0.313	0.024
29	-0.194	0.088	0.028	-0.367	-0.021
30	-0.046	0.095	0.626	-0.231	0.139
31	-0.153	0.082	0.062	-0.314	0.008
Intercept	0.723	0.097	0.000	0.532	0.914
var(Int)	0.000	0.001		0.000	112612.500

Notes: Observations = 2,116, Course Sections = 80

The next model found in Table 5 adds course number by treatment interaction terms to the model of developmental education course pass rates for the combined cohort. The largest estimated effect was for students in Math 99, in which treatment students were estimated to be 12.2 percentage points more likely to pass their developmental education course compared to control students, a statistically significant difference ($p = .001$). The estimated effects were smaller for English 99 (12.2 - 10.3 = 1.9) and Math 98 (12.2 – 9.4 = 2.8), and both interaction effects were significant at the more liberal $p < 0.10$ threshold but not at the $p < 0.05$ level. The post-estimation test found suggestive evidence of significant variation in the treatment effect by course number ($p = 0.093$).

Table 5: Treatment Model of Developmental Education Course Pass Rates for Combined Cohorts, Treatment by Course Number Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group (Math 99)	0.122	0.037	0.001	0.049	0.195
Course (Math 99)					
Engl 99	0.215	0.087	0.014	0.044	0.386
Math 98	0.064	0.061	0.296	-0.056	0.184

Treatment by Course					
Engl 99	-0.103	0.054	0.055	-0.209	0.002
Math 98	-0.094	0.050	0.061	-0.193	0.004
Credits Attempted Pre-Intervention	-0.014	0.001	0.000	-0.017	-0.011
Credits Earned Pre-Intervention	0.017	0.002	0.000	0.013	0.021
Race/Ethnicity (White)					
Black	-0.099	0.031	0.002	-0.161	-0.038
Other	-0.058	0.024	0.017	-0.106	-0.010
Female (Male)	0.103	0.022	0.000	0.059	0.146
Pell Received	0.000	0.000	0.000	0.000	0.000
Age Category (<18)					
18-21.99	-0.078	0.058	0.179	-0.192	0.036
22-24.99	-0.046	0.066	0.491	-0.175	0.084
25-29.99	0.044	0.065	0.498	-0.083	0.171
30-39.99	0.035	0.064	0.583	-0.091	0.161
40-49.99	-0.077	0.071	0.276	-0.216	0.062
50+	-0.101	0.093	0.276	-0.282	0.081
Block ID (Block 1)					
2	-0.003	0.096	0.977	-0.192	0.186
3	0.056	0.102	0.581	-0.144	0.257
4	-0.076	0.102	0.457	-0.275	0.124
5	-0.219	0.098	0.025	-0.412	-0.027
6	0.062	0.111	0.574	-0.155	0.279
7	0.133	0.078	0.087	-0.019	0.286
8	0.070	0.071	0.328	-0.070	0.209
9	0.012	0.077	0.873	-0.138	0.163
10	0.091	0.078	0.240	-0.061	0.244
11	-0.038	0.078	0.624	-0.190	0.114
12	0.050	0.067	0.454	-0.081	0.182
13	0.154	0.098	0.116	-0.038	0.346

14	0.127	0.069	0.066	-0.009	0.262
15	0.099	0.068	0.143	-0.034	0.232
16	0.191	0.053	0.000	0.087	0.295
17	0.318	0.094	0.001	0.134	0.502
18	0.000	0.095	1.000	-0.187	0.187
19	-0.025	0.095	0.791	-0.212	0.162
20	-0.127	0.095	0.183	-0.314	0.060
21	-0.160	0.100	0.109	-0.355	0.035
22	-0.164	0.089	0.067	-0.339	0.011
23	0.068	0.071	0.340	-0.071	0.206
24	0.046	0.071	0.522	-0.094	0.185
25	-0.050	0.074	0.500	-0.195	0.095
26	-0.157	0.083	0.059	-0.320	0.006
27	-0.050	0.076	0.513	-0.199	0.099
28	0.000	(omitted)			
29	-0.022	0.057	0.708	-0.134	0.091
30	0.115	0.066	0.079	-0.013	0.244
31	0.000	(omitted)			
Intercept	0.526	0.071	0.000	0.387	0.665
Var(Int)	0.000	0.000		0.000	0.000

Notes: Observations = 2,116, Course Sections = 80

Developmental Education Course Grades

The next analyses estimate the effect of access to the mobile apps on the grade students received in their developmental education courses for both cohorts. The first model estimates an overall treatment effect and does not include treatment by course interactions. The results of this model, found in Table 6, show that students in treatment course sections received a grade in their developmental education course 0.14 points higher than students in the control group on average, a statistically significant difference ($p = 0.032$).

Table 6: Treatment Model of Developmental Education Course Grades for Combined Cohorts, no Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.136	0.063	0.032	0.012	0.260

Credits Attempted Pre-Intervention	-0.045	0.005	0.000	-0.054	-0.036
Credits Earned Pre-Intervention	0.049	0.006	0.000	0.037	0.061
Race/Ethnicity (White)					
Black	-0.330	0.093	0.000	-0.513	-0.147
Other	-0.143	0.073	0.049	-0.286	0.000
Female (Male)	0.329	0.067	0.000	0.198	0.461
Pell Received	0.000	0.000	0.000	0.000	0.000
Age Category (<18)					
18-21.99	-0.311	0.176	0.077	-0.655	0.033
22-24.99	-0.174	0.199	0.382	-0.564	0.216
25-29.99	0.128	0.195	0.510	-0.254	0.511
30-39.99	0.227	0.193	0.241	-0.152	0.606
40-49.99	-0.209	0.215	0.331	-0.631	0.213
50+	-0.183	0.283	0.516	-0.737	0.370
Block ID (Block 1)					
2	-0.353	0.282	0.211	-0.906	0.200
3	-0.163	0.300	0.587	-0.750	0.424
4	-0.403	0.298	0.176	-0.987	0.181
5	-1.028	0.288	0.000	-1.591	-0.464
6	-0.273	0.325	0.400	-0.910	0.364
7	-0.197	0.289	0.495	-0.764	0.369
8	-0.668	0.274	0.015	-1.206	-0.131
9	-0.793	0.287	0.006	-1.356	-0.231
10	-0.428	0.289	0.139	-0.994	0.138
11	-0.967	0.289	0.001	-1.533	-0.402
12	-0.557	0.265	0.035	-1.077	-0.038
13	-0.205	0.338	0.545	-0.866	0.457
14	-0.401	0.281	0.154	-0.953	0.150
15	-0.436	0.278	0.116	-0.980	0.108
16	-0.250	0.250	0.317	-0.739	0.239

17	0.442	0.334	0.185	-0.212	1.096
18	0.062	0.285	0.828	-0.497	0.621
19	-0.044	0.283	0.876	-0.598	0.510
20	-0.404	0.290	0.164	-0.972	0.165
21	-0.682	0.296	0.021	-1.262	-0.101
22	-0.645	0.266	0.015	-1.167	-0.123
23	-0.155	0.284	0.585	-0.711	0.401
24	-0.458	0.274	0.095	-0.996	0.080
25	-0.644	0.287	0.025	-1.206	-0.082
26	-1.205	0.313	0.000	-1.819	-0.591
27	-0.685	0.297	0.021	-1.267	-0.103
28	-0.461	0.255	0.071	-0.960	0.039
29	-0.824	0.260	0.002	-1.334	-0.314
30	-0.356	0.278	0.200	-0.902	0.189
31	-0.647	0.240	0.007	-1.117	-0.177
Intercept	2.663	0.287	0.000	2.100	3.227
var(Int)	0.000	0.000		0.000	.

Notes: Observations = 2,005, Course Sections = 80

The next model adds course number by treatment interaction terms to the model of developmental education course grades for the combined cohorts. The largest estimated effect was for students in Math 99, in which treatment students earned grades in developmental education courses 0.21 grade points higher than control group students in the same course number. This difference was 0.02 (0.189 points less) for students who enrolled in Engl 99 and 0.17 (0.040 points less) for students in Math 99. Neither of these estimates was statistically significant, and the post-estimation test found no evidence of significant variation in the treatment effect by course number ($p = 0.469$).

Table 7: Treatment Model of Developmental Education Course Grades for Combined Cohorts, Treatment by Course Number Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group (Math 99)	0.206	0.111	0.064	-0.012	0.425
Course (Math 99)					
Engl 99	0.758	0.258	0.003	0.252	1.264
Math 98	0.213	0.190	0.261	-0.158	0.585

Treatment by Course (Math 99)					
Engl 99	-0.189	0.162	0.242	-0.507	0.128
Math 98	-0.040	0.152	0.791	-0.337	0.257
Credits Attempted Pre-Intervention	-0.045	0.005	0.000	-0.054	-0.036
Credits Earned Pre-Intervention	0.049	0.006	0.000	0.037	0.061
Race/Ethnicity (White)					
Black	-0.331	0.093	0.000	-0.514	-0.148
Other	-0.139	0.073	0.057	-0.281	0.004
Female (Male)	0.329	0.067	0.000	0.198	0.460
Pell Received	0.000	0.000	0.000	0.000	0.000
Age Category (<18)					
18-21.99	-0.302	0.176	0.086	-0.646	0.043
22-24.99	-0.161	0.199	0.417	-0.552	0.229
25-29.99	0.140	0.195	0.472	-0.242	0.523
30-39.99	0.239	0.194	0.217	-0.141	0.618
40-49.99	-0.197	0.215	0.361	-0.619	0.225
50+	-0.171	0.283	0.545	-0.725	0.383
Block ID (Block 1)					
2	-0.361	0.282	0.201	-0.914	0.193
3	-0.158	0.299	0.597	-0.745	0.429
4	-0.408	0.298	0.171	-0.992	0.176
5	-1.038	0.288	0.000	-1.601	-0.474
6	-0.272	0.325	0.402	-0.908	0.364
7	0.267	0.233	0.252	-0.190	0.724
8	-0.204	0.214	0.341	-0.624	0.216
9	-0.329	0.230	0.152	-0.781	0.122
10	0.032	0.233	0.889	-0.424	0.489
11	-0.508	0.232	0.029	-0.963	-0.053
12	-0.090	0.203	0.658	-0.487	0.308
13	0.255	0.291	0.381	-0.316	0.826

14	0.259	0.204	0.204	-0.141	0.659
15	0.221	0.200	0.268	-0.171	0.614
16	0.415	0.158	0.008	0.106	0.724
17	1.114	0.276	0.000	0.573	1.655
18	0.054	0.285	0.850	-0.505	0.613
19	-0.049	0.283	0.861	-0.603	0.504
20	-0.410	0.290	0.158	-0.979	0.159
21	-0.705	0.297	0.017	-1.286	-0.124
22	-0.637	0.266	0.017	-1.159	-0.115
23	0.307	0.226	0.174	-0.136	0.750
24	0.004	0.215	0.985	-0.418	0.426
25	-0.182	0.230	0.428	-0.633	0.268
26	-0.736	0.263	0.005	-1.252	-0.220
27	-0.218	0.244	0.373	-0.696	0.261
28	0.000	(omitted)			
29	-0.157	0.176	0.371	-0.501	0.187
30	0.302	0.199	0.129	-0.088	0.691
31	0.000	(omitted)			
Intercept	1.962	0.216	0.000	1.539	2.384
Var(Int)	0.000	0.000		0.000	.

Notes: Observations = 2,005, Course Sections = 80

Next-Semester Persistence

The remaining analyses in the impact evaluation for this APR assess the next-semester outcomes for the combined cohorts. The sample for these analyses is delimited to students who were only enrolled in one of the three developmental education courses to prevent the sample contains students enrolled in both treatment and control group courses. The first analysis investigates the rates at which students persisted to the next long semester, defined as students in the Spring 2017 cohort enrolling in BPCC in Fall 2017 and students in the Fall 2017 cohort enrolling in Spring 2018. This outcome is defined dichotomously (yes = 1, no =0), making the treatment effect estimates represent the percentage point increase in the likelihood of students persisting to the next semester.

Table 8 contains the results of the first model which estimates an overall treatment effect across all three courses and does not contain treatment by course interactions. Students in the treatment group were estimated to be 2.5 percentage points more likely to persist to the next long semester, but this difference was not statistically significant ($p = 0.247$).

Table 8: Treatment Model of Next Semester Persistence for Combined Cohorts, no Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.025	0.022	0.247	-0.018	0.068
Credits Attempted Pre-Intervention	-0.013	0.002	0.000	-0.015	-0.010
Credits Earned Pre-Intervention	0.017	0.002	0.000	0.013	0.021
Race/Ethnicity (White)					
Black	-0.024	0.033	0.472	-0.089	0.041
Other	-0.010	0.025	0.679	-0.060	0.039
Female (Male)	0.030	0.023	0.192	-0.015	0.076
Pell Received	0.000	0.000	0.000	0.000	0.000
Age Category (<18)					
18-21.99	-0.050	0.064	0.437	-0.176	0.076
22-24.99	-0.061	0.073	0.401	-0.203	0.081
25-29.99	-0.014	0.071	0.838	-0.153	0.124
30-39.99	0.034	0.070	0.630	-0.103	0.171
40-49.99	0.003	0.077	0.974	-0.149	0.154
50+	0.025	0.095	0.795	-0.161	0.210
Block ID (Block 1)					
2	0.061	0.107	0.571	-0.149	0.270
3	0.135	0.112	0.228	-0.084	0.354
4	0.095	0.116	0.412	-0.132	0.322
5	0.043	0.105	0.680	-0.162	0.249
6	-0.099	0.176	0.573	-0.445	0.246
7	0.137	0.103	0.185	-0.066	0.340
8	0.079	0.099	0.425	-0.115	0.273
9	0.199	0.103	0.052	-0.002	0.400
10	0.197	0.102	0.054	-0.003	0.398
11	0.165	0.101	0.103	-0.034	0.364
12	0.180	0.095	0.058	-0.006	0.365

13	-0.121	0.186	0.516	-0.486	0.244
14	-0.052	0.100	0.602	-0.247	0.143
15	0.187	0.098	0.056	-0.005	0.379
16	0.156	0.089	0.078	-0.018	0.330
17	-0.058	0.155	0.707	-0.363	0.246
18	0.273	0.104	0.009	0.069	0.478
19	0.233	0.105	0.027	0.026	0.440
20	0.156	0.101	0.120	-0.041	0.354
21	0.125	0.108	0.247	-0.087	0.337
22	0.125	0.095	0.187	-0.061	0.310
23	0.221	0.098	0.024	0.029	0.414
24	0.276	0.099	0.006	0.081	0.471
25	0.203	0.103	0.048	0.002	0.405
26	0.059	0.105	0.573	-0.147	0.265
27	0.107	0.100	0.288	-0.090	0.303
28	0.138	0.090	0.125	-0.038	0.314
29	0.188	0.090	0.037	0.011	0.365
30	0.174	0.096	0.071	-0.015	0.362
31	0.219	0.085	0.010	0.052	0.386
Intercept	0.479	0.104	0.000	0.275	0.683
var(Int)	3.24^{e-21}	1.89^{e-20}		3.40^{e-26}	3.08^{e-16}

Notes: Observations = 1,714, Course Sections = 80

The next model includes treatment by course interaction terms to explore whether the effect of access to the mobile apps on next-semester persistence varies across the three courses. The results show that treatment students in Math 99 were 9.0 percentage points more likely to persist to the next semester compared to control students, a statistically significant difference ($p = 0.041$).

Treatment students in English 99 were 3.2 percentage points more likely to persist and treatment students were 2.8 percentage points less likely to persist compared to control group students. Although the point estimate suggests that the difference in the treatment effect varied significantly between Math 98 and Math 99 students ($p = 0.044$), the post-estimation test found insufficient evidence to conclude there was significant variation in the treatment effect across courses ($p = 0.152$).

Table 9: Treatment Model of Next Semester Persistence for Combined Cohorts, Treatment by Course Number Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group (Math 99)	0.090	0.044	0.041	0.004	0.177
Course (Math 99)					
Engl 99	0.167	0.094	0.078	-0.018	0.352
Math 98	0.282	0.091	0.002	0.105	0.460
Treatment by Course (Math 99)					
Engl 99	-0.058	0.056	0.303	-0.169	0.052
Math 98	-0.116	0.057	0.044	-0.228	-0.003
Credits Attempted Pre-Intervention	-0.012	0.002	0.000	-0.015	-0.010
Credits Earned Pre-Intervention	0.017	0.002	0.000	0.013	0.021
Race/Ethnicity (White)					
Black	-0.025	0.033	0.442	-0.090	0.039
Other	-0.013	0.025	0.606	-0.062	0.036
Female (Male)	0.029	0.023	0.214	-0.017	0.074
Pell Received	0.000	0.000	0.000	0.000	0.000
Age Category (<18)					
18-21.99	-0.053	0.064	0.409	-0.179	0.073
22-24.99	-0.066	0.073	0.360	-0.208	0.076
25-29.99	-0.021	0.071	0.764	-0.160	0.117
30-39.99	0.027	0.070	0.696	-0.110	0.165
40-49.99	-0.005	0.077	0.953	-0.156	0.147
50+	0.017	0.095	0.855	-0.168	0.203
Block ID (Block 1)					
2	0.061	0.107	0.568	-0.148	0.271
3	0.126	0.112	0.262	-0.094	0.345
4	0.092	0.116	0.425	-0.135	0.319
5	0.042	0.105	0.686	-0.163	0.248
6	-0.090	0.176	0.608	-0.436	0.255

7	-0.001	0.080	0.994	-0.157	0.156
8	-0.059	0.074	0.428	-0.203	0.086
9	0.062	0.079	0.431	-0.092	0.216
10	0.060	0.078	0.442	-0.093	0.214
11	0.028	0.077	0.714	-0.123	0.179
12	0.043	0.068	0.524	-0.090	0.177
13	-0.258	0.174	0.137	-0.599	0.083
14	-0.278	0.068	0.000	-0.412	-0.144
15	-0.036	0.066	0.583	-0.166	0.094
16	-0.073	0.051	0.156	-0.173	0.028
17	-0.282	0.138	0.041	-0.551	-0.012
18	0.272	0.104	0.009	0.068	0.476
19	0.233	0.105	0.027	0.027	0.440
20	0.155	0.101	0.123	-0.042	0.352
21	0.132	0.108	0.220	-0.079	0.344
22	0.115	0.095	0.224	-0.070	0.301
23	0.083	0.073	0.254	-0.060	0.226
24	0.138	0.075	0.064	-0.008	0.285
25	0.066	0.079	0.401	-0.089	0.221
26	-0.076	0.082	0.357	-0.237	0.086
27	-0.029	0.076	0.698	-0.178	0.119
28	0.000	(omitted)			
29	-0.045	0.055	0.409	-0.153	0.062
30	-0.051	0.063	0.418	-0.175	0.073
31	0.000	(omitted)			
Intercept	0.451	0.105	0.000	0.246	0.657
Var(Int)	9.53^{e-25}	4.36^{e-24}		1.22^{e-28}	7.43^{e-21}

Notes: Observations = 1,714, Course Sections = 80

Next-Semester GPA

The next analyses investigate the effect of the treatment on the GPA students received in the next semester. The sample is further delimited to students who enrolled and attempted courses in the following semester (*n* = 1,176). GPA was calculated on a 4.0 scale as it was in previous analyses. The first model estimates the overall treatment effect across all three courses, the results of which are found in Table 10. Students in the treatment group were estimated to earn a next-semester GPA 0.14 points higher than control group students, a marginally significant difference (p = 0.053).

Table 10: Treatment Model of Next-Semester GPA for Combined Cohorts, no Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.135	0.069	0.053	-0.002	0.271
Credits Attempted Pre-Intervention	-0.033	0.005	0.000	-0.044	-0.023
Credits Earned Pre-Intervention	0.044	0.007	0.000	0.030	0.057
Race/Ethnicity (White)					
Black	-0.303	0.106	0.004	-0.510	-0.096
Other	-0.096	0.079	0.220	-0.251	0.058
Female (Male)	0.105	0.074	0.155	-0.040	0.250
Pell Received	0.000	0.000	0.000	0.000	0.000
Age Category (<18)					
18-21.99	0.001	0.199	0.994	-0.388	0.390
22-24.99	0.229	0.227	0.312	-0.216	0.674
25-29.99	0.096	0.218	0.661	-0.332	0.523
30-39.99	0.461	0.216	0.033	0.038	0.883
40-49.99	0.424	0.238	0.075	-0.042	0.891
50+	0.268	0.283	0.344	-0.286	0.822
Block ID (Block 1)					
2	-0.572	0.372	0.124	-1.300	0.157
3	-0.271	0.380	0.475	-1.017	0.474
4	-0.504	0.395	0.202	-1.278	0.270
5	-0.477	0.377	0.206	-1.216	0.262
6	-0.985	0.725	0.174	-2.407	0.437
7	-0.126	0.351	0.720	-0.814	0.563
8	0.201	0.348	0.564	-0.481	0.883

9	0.291	0.344	0.399	-0.385	0.966
10	0.273	0.343	0.426	-0.400	0.946
11	-0.557	0.341	0.102	-1.226	0.111
12	0.181	0.324	0.576	-0.454	0.816
13	-0.450	0.862	0.602	-2.140	1.240
14	0.539	0.359	0.133	-0.164	1.242
15	0.457	0.334	0.171	-0.197	1.111
16	0.061	0.308	0.844	-0.543	0.664
17	-0.900	0.587	0.125	-2.051	0.250
18	-0.591	0.345	0.087	-1.267	0.085
19	-0.626	0.351	0.074	-1.314	0.062
20	-0.654	0.343	0.057	-1.326	0.019
21	-0.283	0.370	0.443	-1.008	0.441
22	-0.349	0.325	0.284	-0.986	0.289
23	0.107	0.331	0.746	-0.542	0.757
24	0.061	0.330	0.854	-0.585	0.707
25	0.186	0.343	0.587	-0.486	0.859
26	-0.122	0.367	0.738	-0.841	0.596
27	0.030	0.344	0.931	-0.645	0.705
28	-0.193	0.312	0.537	-0.805	0.419
29	0.075	0.313	0.811	-0.539	0.688
30	0.167	0.328	0.610	-0.475	0.809
31	0.172	0.297	0.563	-0.411	0.754
Intercept	1.952	0.350	0.000	1.266	2.637
var(Int)	6.85^{e-25}	4.07^{e-24}		5.97^{e-30}	7.86^{e-20}

Notes: Observations = 1,176, Course Sections = 80

The next model, found in Table 11, adds treatment by course number interaction terms to the model of next-semester GPA to examine whether the effect varies significantly across the three courses. The results suggest that the effect of the mobile apps on next-semester GPA was concentrated among students in Math 99, in which treatment students received a GPA 0.37 points higher than students in the

control group, a statistically significant difference (p = 0.001). The effect was minimal for students in the other two courses.

Treatment students in English 99 earned a next-semester GPA 0.03 points higher than control students and treatment students in Math 99 earned a next-semester GPA 0.02 points less than control students. The point estimates suggest that the effect of the treatment did vary significantly across courses, and the post-estimation test similarly found significant variation in the treatment effect by course number (p = 0.032).

Table 11: Treatment Model of Next Semester GPA for Combined Cohorts, Treatment by Course Number Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group (Math 99)	0.370	0.114	0.001	0.147	0.593
Course (Math 99)					
Engl 99	0.047	0.319	0.883	-0.579	0.673
Math 98	-0.115	0.195	0.557	-0.497	0.268
Treatment by Course (Math 99)					
Engl 99	-0.343	0.185	0.063	-0.704	0.019
Math 98	-0.394	0.158	0.013	-0.704	-0.084
Credits Attempted Pre-Intervention	-0.033	0.005	0.000	-0.043	-0.023
Credits Earned Pre-Intervention	0.043	0.007	0.000	0.029	0.057
Race/Ethnicity (White)					
Black	-0.289	0.106	0.006	-0.496	-0.082
Other	-0.090	0.078	0.253	-0.244	0.064
Female (Male)	0.112	0.074	0.127	-0.032	0.257
Pell Received	0.000	0.000	0.000	0.000	0.000
Age Category (<18)					
18-21.99	0.007	0.198	0.973	-0.382	0.395
22-24.99	0.241	0.227	0.288	-0.204	0.686
25-29.99	0.114	0.218	0.603	-0.314	0.541
30-39.99	0.490	0.215	0.023	0.067	0.912
40-49.99	0.446	0.238	0.061	-0.020	0.913
50+	0.292	0.282	0.301	-0.261	0.845
Block ID (Block 1)					

2	-0.572	0.371	0.123	-1.298	0.155
3	-0.267	0.379	0.482	-1.010	0.476
4	-0.504	0.394	0.200	-1.276	0.268
5	-0.478	0.376	0.204	-1.215	0.259
6	-1.024	0.725	0.158	-2.444	0.396
7	0.044	0.252	0.862	-0.450	0.537
8	0.383	0.247	0.121	-0.101	0.866
9	0.474	0.241	0.050	0.001	0.946
10	0.453	0.241	0.060	-0.020	0.926
11	-0.372	0.239	0.120	-0.841	0.097
12	0.328	0.213	0.123	-0.089	0.746
13	-0.268	0.825	0.746	-1.886	1.350
14	0.433	0.242	0.073	-0.041	0.908
15	0.333	0.204	0.102	-0.066	0.731
16	-0.057	0.157	0.715	-0.365	0.250
17	-1.008	0.524	0.054	-2.034	0.019
18	-0.596	0.344	0.083	-1.270	0.079
19	-0.624	0.350	0.075	-1.310	0.062
20	-0.657	0.343	0.055	-1.329	0.014
21	-0.317	0.371	0.393	-1.045	0.411
22	-0.351	0.324	0.279	-0.986	0.284
23	0.291	0.223	0.193	-0.147	0.729
24	0.229	0.222	0.303	-0.207	0.664
25	0.354	0.241	0.142	-0.118	0.826
26	0.015	0.274	0.957	-0.523	0.552
27	0.192	0.244	0.432	-0.287	0.671
28	0.000	(omitted)			
29	-0.018	0.169	0.916	-0.348	0.313
30	0.041	0.191	0.832	-0.335	0.416
31	0.000	(omitted)			

Intercept	1.957	0.232	0.000	1.502	2.412
Var(Int)	1.05^{e-22}	4.74^{e-22}		1.54^{e-26}	7.18^{e-19}

Notes: Observations = 1,176, Course Sections = 80

Next-Semester Course Pass Rates

The next analysis assesses the effect of the treatment on students' next-semester course pass rates, defined as the percentage of attempted courses that students passed (0-100%). The sample is once again delimited to students who enrolled in the subsequent semester and attempted courses. The results in Table 12 show the overall treatment effect across all three course numbers. Students in the treatment group were estimated to pass 3.7 percentage points more of their courses compared to students in the control group, a marginally significant difference (p = 0.074).

Table 12: Treatment Model of Next Semester Course Pass Rates for Combined Cohorts, no Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.037	0.021	0.074	-0.004	0.078
Credits Attempted Pre-Intervention	-0.010	0.002	0.000	-0.013	-0.007
Credits Earned Pre-Intervention	0.014	0.002	0.000	0.010	0.018
Race/Ethnicity (White)					
Black	-0.062	0.032	0.051	-0.124	0.000
Other	-0.014	0.024	0.547	-0.060	0.032
Female (Male)	0.025	0.022	0.265	-0.019	0.068
Pell Received	0.000	0.000	0.003	0.000	0.000
Age Category (<18)					
18-21.99	-0.057	0.060	0.341	-0.174	0.060
22-24.99	-0.021	0.068	0.759	-0.154	0.113
25-29.99	-0.037	0.065	0.568	-0.166	0.091
30-39.99	0.017	0.065	0.796	-0.110	0.143
40-49.99	0.009	0.071	0.895	-0.131	0.149
50+	0.004	0.085	0.962	-0.162	0.170
Block ID (Block 1)					
2	-0.183	0.112	0.101	-0.402	0.036
3	-0.047	0.114	0.683	-0.270	0.177
4	-0.038	0.118	0.747	-0.271	0.194

5	-0.121	0.113	0.285	-0.343	0.101
6	-0.263	0.218	0.227	-0.690	0.163
7	-0.026	0.105	0.806	-0.233	0.181
8	0.094	0.104	0.367	-0.111	0.299
9	0.105	0.103	0.310	-0.098	0.308
10	0.066	0.103	0.520	-0.136	0.268
11	-0.108	0.102	0.291	-0.309	0.092
12	0.086	0.097	0.374	-0.104	0.277
13	-0.033	0.259	0.900	-0.540	0.475
14	0.174	0.108	0.107	-0.037	0.384
15	0.110	0.100	0.274	-0.087	0.306
16	0.041	0.092	0.655	-0.140	0.222
17	-0.146	0.176	0.408	-0.491	0.200
18	-0.140	0.103	0.176	-0.343	0.063
19	-0.150	0.105	0.156	-0.356	0.057
20	-0.226	0.103	0.028	-0.428	-0.024
21	-0.085	0.111	0.442	-0.303	0.132
22	-0.061	0.098	0.532	-0.252	0.130
23	0.038	0.099	0.702	-0.157	0.233
24	0.028	0.099	0.779	-0.166	0.222
25	0.095	0.103	0.354	-0.106	0.297
26	-0.033	0.110	0.766	-0.248	0.183
27	0.013	0.103	0.902	-0.190	0.215
28	-0.033	0.094	0.722	-0.217	0.150
29	0.051	0.094	0.583	-0.133	0.236
30	0.043	0.098	0.662	-0.150	0.236
31	0.062	0.089	0.489	-0.113	0.236
Intercept	0.707	0.105	0.000	0.501	0.913
var(Int)	2.35^{e-26}	1.21^{e-22}		0	.

Notes: Observations = 1,176, Course Sections = 80

The next analysis adds course number by treatment interaction terms to the model of next-semester course pass rates to examine whether this effect varies significantly across groups. The largest estimated effect was for students in Math 99, in which treatment students passed 8.2 percentage points more of their courses in the next semester compared to control students, a statistically significant difference ($p = 0.016$).

Treatment students in English 99 passed 0.1 percentage points fewer courses than control students and treatment students in Math 98 passed 1.9 percentage points more courses than control students. Neither of these estimates was statistically significant, and the post-estimation test found no evidence of significant variation in the treatment effect by course number ($p = 0.225$).

Table 13: Treatment Model of Next Semester Course Pass Rates for Combined Cohorts, Treatment by Course Number Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.082	0.034	0.016	0.015	0.149
Course (Math 99)					
Engl 99	-0.005	0.096	0.955	-0.193	0.183
Math 98	-0.055	0.059	0.349	-0.170	0.060
Treatment by Course					
Engl 99	-0.088	0.055	0.113	-0.197	0.021
Math 98	-0.063	0.048	0.184	-0.156	0.030
Credits Attempted Pre-Intervention	-0.010	0.002	0.000	-0.013	-0.007
Credits Earned Pre-Intervention	0.014	0.002	0.000	0.009	0.018
Race/Ethnicity (White)					
Black	-0.060	0.032	0.060	-0.122	0.003
Other	-0.012	0.024	0.604	-0.058	0.034
Female (Male)	0.026	0.022	0.244	-0.018	0.069
Pell Received	0.000	0.000	0.002	0.000	0.000
Age Category (<18)					
18-21.99	-0.054	0.060	0.369	-0.170	0.063
22-24.99	-0.016	0.068	0.815	-0.150	0.118
25-29.99	-0.032	0.066	0.629	-0.160	0.097
30-39.99	0.024	0.065	0.710	-0.103	0.151
40-49.99	0.016	0.072	0.822	-0.124	0.156

50+	0.010	0.085	0.909	-0.157	0.176
Block ID (Block 1)					
2	-0.185	0.111	0.098	-0.403	0.034
3	-0.046	0.114	0.687	-0.269	0.177
4	-0.038	0.118	0.747	-0.270	0.194
5	-0.122	0.113	0.279	-0.344	0.099
6	-0.278	0.218	0.202	-0.705	0.149
7	0.005	0.076	0.948	-0.143	0.153
8	0.126	0.074	0.089	-0.019	0.272
9	0.138	0.072	0.058	-0.005	0.280
10	0.098	0.073	0.178	-0.044	0.240
11	-0.076	0.072	0.291	-0.217	0.065
12	0.115	0.064	0.073	-0.011	0.240
13	0.000	0.248	1.000	-0.486	0.486
14	0.125	0.073	0.086	-0.018	0.267
15	0.057	0.061	0.351	-0.063	0.177
16	-0.010	0.047	0.831	-0.102	0.082
17	-0.195	0.157	0.216	-0.503	0.114
18	-0.144	0.103	0.165	-0.346	0.059
19	-0.151	0.105	0.152	-0.357	0.056
20	-0.230	0.103	0.026	-0.431	-0.028
21	-0.100	0.112	0.371	-0.319	0.119
22	-0.062	0.097	0.523	-0.253	0.129
23	0.071	0.067	0.292	-0.061	0.202
24	0.058	0.067	0.381	-0.072	0.189
25	0.126	0.072	0.082	-0.016	0.268
26	-0.006	0.082	0.944	-0.167	0.156
27	0.043	0.073	0.561	-0.101	0.187
28	0.000	(omitted)			
29	0.005	0.051	0.924	-0.094	0.104

30	-0.010	0.058	0.865	-0.123	0.103
31	0.000	(omitted)			
Intercept	0.735	0.070	0.000	0.598	0.872
Var(Int)	2.61^{e-25}	1.21^{e-24}		2.93^{e-29}	2.33^{e-21}

Notes: Observations = 1,176, Course Sections = 80

Next-Semester Credits Earned

The final analysis estimates the effect of access to the mobile apps on the number of credits students earned in the subsequent semester. In this instance, the sample includes all students who were enrolled in only one intervention course (n = 1,714), and students who did not persist to the next semester are treated as having earned zero credits. The results of the model found in Table 14 show that, across the three developmental education courses, students given access to the mobile apps earned close to half a credit (0.46) more than students in the control group, a marginally significant effect (p = 0.072).

Table 14: Treatment Model of Next Semester Credits Earned for Combined Cohorts, no Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.458	0.254	0.072	-0.040	0.956
Credits Attempted Pre-Intervention	-0.167	0.018	0.000	-0.202	-0.132
Credits Earned Pre-Intervention	0.231	0.024	0.000	0.184	0.278
Race/Ethnicity (White)					
Black	-0.793	0.385	0.039	-1.547	-0.039
Other	-0.300	0.292	0.303	-0.872	0.271
Female (Male)	0.355	0.270	0.190	-0.175	0.885
Pell Received	0.000	0.000	0.055	0.000	0.000
Age Category (<18)					
18-21.99	-0.936	0.748	0.210	-2.402	0.529
22-24.99	-1.194	0.843	0.157	-2.847	0.458
25-29.99	-0.978	0.821	0.234	-2.587	0.632
30-39.99	-0.560	0.814	0.491	-2.155	1.034
40-49.99	-0.602	0.899	0.503	-2.363	1.160
50+	-0.918	1.099	0.403	-3.073	1.236
Block ID (Block 1)					
2	-0.253	1.244	0.839	-2.692	2.186

3	0.567	1.300	0.663	-1.982	3.115
4	0.241	1.347	0.858	-2.400	2.882
5	-0.220	1.219	0.857	-2.609	2.169
6	-1.403	2.050	0.494	-5.420	2.614
7	0.970	1.202	0.420	-1.386	3.325
8	1.232	1.151	0.285	-1.024	3.487
9	2.700	1.192	0.023	0.364	5.036
10	2.506	1.190	0.035	0.174	4.837
11	0.197	1.178	0.867	-2.112	2.506
12	1.893	1.101	0.086	-0.265	4.051
13	0.166	2.165	0.939	-4.078	4.410
14	0.962	1.157	0.406	-1.305	3.229
15	2.566	1.138	0.024	0.336	4.796
16	1.502	1.030	0.145	-0.516	3.521
17	-0.899	1.805	0.619	-4.437	2.640
18	0.744	1.212	0.539	-1.631	3.119
19	1.111	1.226	0.365	-1.292	3.514
20	-0.761	1.170	0.516	-3.054	1.533
21	0.693	1.255	0.581	-1.767	3.153
22	0.912	1.100	0.407	-1.244	3.069
23	2.313	1.142	0.043	0.075	4.550
24	2.416	1.156	0.037	0.150	4.681
25	2.173	1.196	0.069	-0.171	4.517
26	0.386	1.222	0.752	-2.009	2.780
27	0.365	1.165	0.754	-1.918	2.647
28	0.995	1.043	0.340	-1.050	3.041
29	2.546	1.049	0.015	0.490	4.601
30	2.011	1.117	0.072	-0.179	4.201
31	2.635	0.992	0.008	0.692	4.579
Intercept	4.324	1.207	0.000	1.958	6.690

var(Int)	1.98^{e-13}	9.34^{e-13}		1.87^{e-17}	2.08^{e-09}

Notes: Observations = 1,714, Course Sections = 80

The model found in Table 15 below adds course number by treatment interaction terms to the model of next semester credits earned. The largest estimated effect was for students in Math 99, in which treatment students earned 0.55 more credits in the following semester compared to control students. However, this difference was not statistically significant, nor were the interaction effects exploring whether the treatment effect varied across the three courses. The post-estimation test found no evidence of significant variation in the treatment effect by course number (p = 0.925).

Table 15: Treatment Model of Next Semester Credits Earned for Combined Cohorts, Treatment by Course Number Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.547	0.422	0.195	-0.280	1.374
Course (Math 99)					
Engl 99	-2.496	1.056	0.018	-4.565	-0.428
Math 98	-1.599	0.713	0.025	-2.996	-0.202
Treatment by Course					
Engl 99	-0.259	0.667	0.698	-1.567	1.049
Math 98	-0.067	0.588	0.910	-1.219	1.086
Credits Attempted Pre-Intervention	-0.167	0.018	0.000	-0.202	-0.132
Credits Earned Pre-Intervention	0.231	0.024	0.000	0.184	0.278
Race/Ethnicity (White)					
Black	-0.791	0.385	0.040	-1.546	-0.036
Other	-0.294	0.292	0.313	-0.867	0.278
Female (Male)	0.358	0.271	0.186	-0.173	0.888
Pell Received	0.000	0.000	0.058	0.000	0.000
Age Category (<18)					
18-21.99	-0.927	0.748	0.215	-2.394	0.540
22-24.99	-1.181	0.844	0.162	-2.835	0.474
25-29.99	-0.961	0.822	0.242	-2.572	0.650
30-39.99	-0.547	0.814	0.502	-2.143	1.049
40-49.99	-0.585	0.900	0.516	-2.348	1.179

50+	-0.905	1.100	0.411	-3.062	1.251
Block ID (Block 1)					
2	-0.255	1.244	0.838	-2.693	2.184
3	0.591	1.302	0.650	-1.961	3.143
4	0.249	1.348	0.853	-2.392	2.890
5	-0.218	1.219	0.858	-2.607	2.170
6	-1.426	2.050	0.487	-5.445	2.593
7	-0.023	0.929	0.981	-1.842	1.797
8	0.239	0.860	0.781	-1.447	1.925
9	1.706	0.914	0.062	-0.085	3.497
10	1.509	0.913	0.098	-0.280	3.298
11	-0.801	0.897	0.372	-2.559	0.957
12	0.902	0.794	0.256	-0.654	2.458
13	-0.825	2.024	0.684	-4.793	3.143
14	-1.661	0.795	0.037	-3.220	-0.102
15	-0.061	0.772	0.937	-1.573	1.451
16	-1.116	0.595	0.061	-2.282	0.051
17	-3.527	1.602	0.028	-6.668	-0.387
18	0.748	1.212	0.537	-1.627	3.123
19	1.110	1.226	0.365	-1.293	3.512
20	-0.758	1.170	0.517	-3.051	1.536
21	0.673	1.256	0.592	-1.789	3.135
22	0.938	1.102	0.395	-1.222	3.098
23	1.319	0.848	0.120	-0.344	2.982
24	1.422	0.871	0.103	-0.285	3.129
25	1.179	0.919	0.200	-0.622	2.980
26	-0.604	0.958	0.528	-2.481	1.273
27	-0.627	0.884	0.478	-2.360	1.106
28	0.000	(omitted)			
29	-0.066	0.638	0.918	-1.317	1.185

30	-0.614	0.736	0.404	-2.056	0.827
31	0.000	(omitted)			
Intercept	6.893	0.869	0.000	5.190	8.596
Var(Int)	3.64^{e-12}	5.36^{e-09}		0	.

Notes: Observations = 1,714, Course Sections = 80

Credential Attainment Rates

The final outcome examined in this evaluation of the effect of the mobile apps on student outcomes is credential attainment. We investigate three separate outcomes related to credential attainment: the receipt of any credential (associate's or certificate), associate's receipt, and certificate receipt.

Table 16 presents the results of the model estimating the effect of access to the mobile apps on the receipt of any credential. No treatment by course interaction term is present in the model. Students in the treatment group were estimated to be 0.8% more likely to complete any credential compared to students in the control group, but this difference was not statistically significant (p = 0.618).

Table 16: Treatment Model of Any Credential Attainment for Combined Cohorts, no Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.008	0.016	0.618	-0.024	0.040
Credits Attempted Pre-Intervention	-0.008	0.001	0.000	-0.011	-0.006
Credits Earned Pre-Intervention	0.017	0.002	0.000	0.014	0.020
Race/Ethnicity (White)					
Black	-0.030	0.025	0.221	-0.079	0.018
Other	-0.043	0.019	0.024	-0.080	-0.006
Female (Male)	-0.004	0.017	0.830	-0.038	0.031
Pell Received	0.000	0.000	0.710	0.000	0.000
Age Category (<18)					
18-21.99	0.026	0.048	0.591	-0.069	0.121
22-24.99	-0.018	0.055	0.746	-0.125	0.089
25-29.99	0.009	0.053	0.866	-0.095	0.113
30-39.99	0.011	0.053	0.828	-0.092	0.115
40-49.99	0.068	0.058	0.242	-0.046	0.182
50+	-0.096	0.071	0.179	-0.235	0.044
Block ID (Block 1)					
2	-0.092	0.080	0.253	-0.250	0.066

3	-0.066	0.084	0.429	-0.231	0.098
4	-0.146	0.087	0.093	-0.317	0.025
5	-0.053	0.079	0.504	-0.207	0.102
6	-0.180	0.133	0.175	-0.439	0.080
7	-0.019	0.078	0.812	-0.171	0.134
8	-0.055	0.074	0.456	-0.201	0.090
9	0.015	0.077	0.848	-0.136	0.166
10	-0.044	0.077	0.567	-0.195	0.107
11	-0.161	0.076	0.034	-0.311	-0.012
12	-0.080	0.071	0.262	-0.219	0.060
13	-0.021	0.140	0.881	-0.295	0.253
14	-0.051	0.075	0.494	-0.198	0.095
15	-0.049	0.074	0.506	-0.193	0.095
16	-0.027	0.067	0.681	-0.158	0.103
17	-0.240	0.117	0.040	-0.469	-0.011
18	-0.136	0.078	0.084	-0.289	0.018
19	-0.130	0.079	0.102	-0.285	0.026
20	-0.115	0.076	0.129	-0.263	0.033
21	-0.110	0.081	0.173	-0.270	0.049
22	-0.102	0.071	0.153	-0.241	0.038
23	-0.098	0.074	0.185	-0.243	0.047
24	-0.029	0.075	0.696	-0.176	0.117
25	-0.088	0.077	0.254	-0.240	0.063
26	-0.112	0.079	0.158	-0.266	0.043
27	-0.093	0.075	0.218	-0.240	0.055
28	-0.124	0.067	0.065	-0.257	0.008
29	-0.076	0.068	0.263	-0.209	0.057
30	-0.123	0.072	0.088	-0.265	0.018
31	-0.042	0.064	0.516	-0.167	0.084
Intercept	0.160	0.078	0.041	0.007	0.313
var(Int)	3.00^{e-25}	1.42^{e-24}		2.74^{e-29}	3.29^{e-21}

Notes: Observations = 1,714, Course Sections = 80

The next model adds treatment by course number interaction terms to explore if the effect of the treatment on credential attainment varied across the three courses. No significant differences were found between courses in the treatment effect. This finding was corroborated by the post-estimation test (p = 0.631).

Table 17: Treatment Model of Any Credential Attainment for Combined Cohorts,

Treatment by Course Number Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.017	0.033	0.611	-0.048	0.082
Course (Math 99)					
Engl 99	-0.111	0.071	0.118	-0.250	0.028
Math 98	-0.044	0.068	0.517	-0.178	0.090
Treatment by Course					
Engl 99	-0.025	0.042	0.556	-0.108	0.058
Math 98	0.003	0.043	0.949	-0.082	0.087
Credits Attempted Pre-Intervention	-0.008	0.001	0.000	-0.011	-0.006
Credits Earned Pre-Intervention	0.017	0.002	0.000	0.014	0.020
Race/Ethnicity (White)					
Black	-0.043	0.019	0.024	-0.080	-0.006
Other	-0.030	0.025	0.233	-0.079	0.019
Female (Male)	-0.004	0.017	0.836	-0.038	0.031
Pell Received	0.000	0.000	0.732	0.000	0.000
Age Category (<18)					
18-21.99	0.025	0.048	0.606	-0.070	0.120
22-24.99	-0.018	0.055	0.739	-0.125	0.089
25-29.99	0.009	0.053	0.872	-0.096	0.113
30-39.99	0.012	0.053	0.819	-0.091	0.115
40-49.99	0.068	0.058	0.245	-0.046	0.182
50+	-0.094	0.071	0.186	-0.233	0.045
Block ID (Block 1)					
2	-0.092	0.080	0.255	-0.249	0.066

3	-0.068	0.084	0.422	-0.233	0.097
4	-0.147	0.087	0.092	-0.318	0.024
5	-0.053	0.079	0.504	-0.207	0.102
6	-0.179	0.133	0.177	-0.439	0.081
7	0.105	0.060	0.081	-0.013	0.222
8	0.068	0.056	0.222	-0.041	0.177
9	0.138	0.059	0.019	0.022	0.254
10	0.080	0.059	0.173	-0.035	0.196
11	-0.037	0.058	0.526	-0.150	0.077
12	0.041	0.051	0.420	-0.059	0.142
13	0.101	0.131	0.438	-0.155	0.358
14	-0.008	0.051	0.872	-0.109	0.092
15	-0.007	0.050	0.896	-0.104	0.091
16	0.016	0.038	0.675	-0.059	0.092
17	-0.198	0.104	0.057	-0.401	0.005
18	-0.136	0.078	0.084	-0.289	0.018
19	-0.129	0.079	0.103	-0.285	0.026
20	-0.115	0.076	0.129	-0.263	0.034
21	-0.109	0.081	0.179	-0.268	0.050
22	-0.103	0.071	0.149	-0.243	0.037
23	0.026	0.055	0.635	-0.081	0.133
24	0.094	0.056	0.095	-0.016	0.204
25	0.035	0.059	0.554	-0.081	0.152
26	0.008	0.062	0.900	-0.114	0.129
27	0.029	0.057	0.618	-0.084	0.141
28	0.000	(omitted)			
29	-0.031	0.041	0.452	-0.112	0.050
30	-0.081	0.048	0.090	-0.174	0.013
31	0.000	(omitted)			
Intercept	0.156	0.079	0.049	0.001	0.311
Var(Int)	0.000	0.000		0.000	0.000

Notes: Observations = 1,714, Course Sections = 80

We next examined if being given access to the mobile apps affected students' likelihood of associate's degree attainment. These results are found in Table 18. Students in the treatment group were 0.8% more likely to complete an associate's degree during the study timeframe compared to the control group, a non-significant difference (p = 0.506).

Table 18: Treatment Model of Associate's Degree Attainment for Combined Cohorts, no Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.008	0.013	0.506	-0.016	0.033
Credits Attempted Pre-Intervention	-0.008	0.001	0.000	-0.010	-0.006
Credits Earned Pre-Intervention	0.013	0.001	0.000	0.011	0.016
Race/Ethnicity (White)					
Black	-0.039	0.014	0.007	-0.067	-0.011
Other	-0.002	0.019	0.917	-0.039	0.035
Female (Male)	-0.005	0.013	0.704	-0.031	0.021
Pell Received	0.000	0.000	0.648	0.000	0.000
Age Category (<18)					
18-21.99	0.038	0.037	0.309	-0.035	0.110
22-24.99	0.028	0.042	0.502	-0.054	0.110
25-29.99	0.042	0.041	0.297	-0.037	0.122
30-39.99	0.058	0.040	0.147	-0.021	0.137
40-49.99	0.049	0.044	0.271	-0.038	0.136
50+	-0.001	0.054	0.986	-0.107	0.106
Block ID (Block 1)					
2	-0.041	0.062	0.507	-0.161	0.080
3	-0.049	0.064	0.448	-0.175	0.077
4	-0.024	0.067	0.721	-0.154	0.107
5	-0.030	0.060	0.624	-0.148	0.089
6	-0.061	0.101	0.545	-0.260	0.137
7	0.032	0.059	0.595	-0.085	0.148
8	0.052	0.057	0.363	-0.060	0.163
9	-0.001	0.059	0.984	-0.117	0.114

10	0.003	0.059	0.954	-0.112	0.119
11	-0.033	0.058	0.568	-0.147	0.081
12	-0.010	0.054	0.855	-0.117	0.097
13	-0.030	0.107	0.780	-0.240	0.180
14	0.050	0.057	0.385	-0.062	0.162
15	0.040	0.056	0.481	-0.071	0.150
16	0.058	0.051	0.253	-0.042	0.158
17	-0.089	0.089	0.318	-0.264	0.086
18	-0.043	0.060	0.474	-0.160	0.075
19	-0.034	0.061	0.571	-0.153	0.084
20	-0.037	0.058	0.521	-0.151	0.076
21	-0.011	0.062	0.860	-0.133	0.111
22	-0.027	0.054	0.614	-0.134	0.079
23	-0.038	0.056	0.496	-0.149	0.072
24	-0.042	0.057	0.458	-0.154	0.070
25	-0.027	0.059	0.643	-0.143	0.088
26	-0.012	0.060	0.847	-0.130	0.107
27	-0.039	0.058	0.493	-0.152	0.073
28	-0.040	0.052	0.443	-0.141	0.062
29	0.007	0.052	0.896	-0.095	0.108
30	-0.028	0.055	0.613	-0.136	0.080
31	0.037	0.049	0.451	-0.059	0.133
Intercept	0.032	0.060	0.590	-0.085	0.149
var(Int)	2.44E-26	1.11E-25		3.22E-30	1.84E-22

Notes: Observations = 1,714, Course Sections = 80

The next model explore whether the effect of the mobile apps on associate's degree attainment varied across the three courses by including treatment by course number interaction terms. The results of this model are found in Table 19. The largest effect on associate's degree attainment was found for students in Math 99, who were 1.6% more likely to earn an associate's degree if they were in the treatment group. However, this difference was not statistically significant, nor were the interaction terms exploring if this effect varied across courses. The post-estimation test also found no significant treatment by course number interaction ($p = 0.484$).

Table 19: Treatment Model of Associate's Degree Attainment for Combined Cohorts, Treatment by Course Number Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.016	0.021	0.438	-0.025	0.057
Course (Math 99)					
Engl 99	-0.025	0.052	0.634	-0.127	0.077
Math 98	-0.073	0.035	0.039	-0.142	-0.004
Treatment by Course					
Engl 99	-0.023	0.033	0.493	-0.087	0.042
Math 98	-0.006	0.029	0.838	-0.063	0.051
Credits Attempted Pre-Intervention	-0.008	0.001	0.000	-0.010	-0.006
Credits Earned Pre-Intervention	0.013	0.001	0.000	0.011	0.016
Race/Ethnicity (White)					
Black	-0.039	0.014	0.008	-0.067	-0.010
Other	-0.002	0.019	0.924	-0.039	0.036
Female (Male)	-0.005	0.013	0.718	-0.031	0.021
Pell Received	0.000	0.000	0.625	0.000	0.000
Age Category (<18)					
18-21.99	0.038	0.037	0.299	-0.034	0.111
22-24.99	0.029	0.042	0.484	-0.053	0.111
25-29.99	0.044	0.041	0.281	-0.036	0.124
30-39.99	0.059	0.040	0.140	-0.019	0.138
40-49.99	0.050	0.044	0.257	-0.037	0.138
50+	0.000	0.054	0.997	-0.106	0.107
Block ID (Block 1)					
2	-0.041	0.062	0.505	-0.162	0.080
3	-0.047	0.064	0.468	-0.173	0.080
4	-0.023	0.067	0.729	-0.154	0.108
5	-0.029	0.060	0.625	-0.148	0.089
6	-0.063	0.101	0.532	-0.262	0.135
7	0.071	0.046	0.120	-0.019	0.161

8	0.092	0.043	0.031	0.008	0.175
9	0.039	0.045	0.394	-0.050	0.127
10	0.043	0.045	0.343	-0.046	0.131
11	0.006	0.044	0.891	-0.081	0.093
12	0.030	0.039	0.445	-0.047	0.107
13	0.010	0.100	0.921	-0.186	0.206
14	0.014	0.039	0.726	-0.063	0.091
15	0.003	0.038	0.928	-0.071	0.078
16	0.023	0.029	0.440	-0.035	0.080
17	-0.125	0.079	0.113	-0.281	0.030
18	-0.043	0.060	0.478	-0.160	0.075
19	-0.034	0.061	0.570	-0.153	0.084
20	-0.037	0.058	0.524	-0.150	0.076
21	-0.013	0.062	0.838	-0.134	0.109
22	-0.025	0.055	0.644	-0.132	0.082
23	0.001	0.042	0.975	-0.081	0.084
24	-0.003	0.043	0.951	-0.087	0.082
25	0.012	0.045	0.787	-0.077	0.101
26	0.028	0.047	0.549	-0.064	0.121
27	0.000	0.044	0.992	-0.085	0.086
28	0.000	(omitted)			
29	-0.028	0.032	0.374	-0.090	0.034
30	-0.064	0.036	0.079	-0.135	0.007
31	0.000	(omitted)			
Intercept	0.063	0.043	0.141	-0.021	0.148
Var(Int)	1.37E-17	8.08E-17		1.30E-22	1.44E-12

Notes: Observations = 1,714, Course Sections = 80

The final outcome investigated was certificate attainment. Table 20 includes the results of the first model estimating the effect of the mobile apps on certificate attainment. Students in the treatment group were 0.3% more likely to earn a certificate compared to the control group, but this difference was not statistically significant ($p = 0.837$).

Table 20: Treatment Model of Certificate Attainment for Combined Cohorts, no Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.003	0.016	0.837	-0.028	0.034
Credits Attempted Pre-Intervention	-0.007	0.001	0.000	-0.009	-0.005
Credits Earned Pre-Intervention	0.014	0.002	0.000	0.011	0.017
Race/Ethnicity (White)					
Black	-0.039	0.024	0.107	-0.086	0.008
Other	-0.040	0.018	0.029	-0.075	-0.004
Female (Male)	-0.006	0.017	0.739	-0.039	0.028
Pell Received	0.000	0.000	0.578	0.000	0.000
Age Category (<18)					
18-21.99	0.023	0.047	0.615	-0.068	0.115
22-24.99	-0.029	0.053	0.584	-0.132	0.075
25-29.99	-0.034	0.051	0.507	-0.135	0.067
30-39.99	0.004	0.051	0.932	-0.095	0.104
40-49.99	0.058	0.056	0.305	-0.053	0.168
50+	-0.069	0.069	0.318	-0.203	0.066
Block ID (Block 1)					
2	-0.058	0.078	0.456	-0.211	0.094
3	-0.037	0.081	0.649	-0.196	0.122
4	-0.116	0.084	0.169	-0.281	0.049
5	-0.027	0.076	0.721	-0.177	0.122
6	-0.148	0.128	0.248	-0.399	0.103
7	0.020	0.075	0.790	-0.127	0.167
8	-0.024	0.072	0.740	-0.165	0.117
9	0.033	0.075	0.656	-0.113	0.179
10	-0.047	0.074	0.528	-0.193	0.099
11	-0.139	0.074	0.060	-0.283	0.006
12	-0.094	0.069	0.171	-0.229	0.041
13	0.000	0.135	1.000	-0.265	0.265
14	-0.043	0.072	0.552	-0.185	0.099

15	-0.032	0.071	0.655	-0.171	0.108
16	-0.010	0.064	0.871	-0.137	0.116
17	-0.208	0.113	0.065	-0.430	0.013
18	-0.114	0.076	0.133	-0.262	0.035
19	-0.105	0.077	0.170	-0.256	0.045
20	-0.089	0.073	0.224	-0.232	0.054
21	-0.082	0.078	0.295	-0.236	0.072
22	-0.086	0.069	0.213	-0.221	0.049
23	-0.068	0.071	0.342	-0.208	0.072
24	-0.017	0.072	0.817	-0.158	0.125
25	-0.093	0.075	0.216	-0.239	0.054
26	-0.100	0.076	0.189	-0.250	0.049
27	-0.058	0.073	0.423	-0.201	0.084
28	-0.091	0.065	0.162	-0.219	0.037
29	-0.051	0.066	0.440	-0.179	0.078
30	-0.113	0.070	0.106	-0.250	0.024
31	-0.026	0.062	0.678	-0.147	0.096
Intercept	0.143	0.075	0.057	-0.004	0.291
var(Int)	1.85E-18	4.85E-15		*	*

Notes: Observations = 1,714, Course Sections = 80

Finally, Table 21 examines whether the effect of the treatment on certificate attainment varied across the three course numbers. Students in Math 99 were 3.0% more likely to complete a certificate compared to students in the control group, but this difference was not statistically significant (p = 0.350). There were also no significant differences between courses in the effect of the treatment, confirmed by the post-estimation test (p = 0.432).

Table 21: Treatment Model of Certificate Attainment for Combined Cohorts, Treatment by Course Number Interaction

	β	SE	p-value	95% Conf. Int.	
Treatment Group	0.030	0.032	0.350	-0.033	0.093
Course (Math 99)					
Engl 99	-0.065	0.069	0.347	-0.199	0.070
Math 98	-0.017	0.066	0.796	-0.146	0.112
Treatment by Course					

Engl 99	-0.051	0.041	0.214	-0.131	0.029
Math 98	-0.019	0.042	0.649	-0.101	0.063
Credits Attempted Pre-Intervention	-0.007	0.001	0.000	-0.009	-0.005
Credits Earned Pre-Intervention	0.014	0.002	0.000	0.011	0.017
Race/Ethnicity (White)					
Black	-0.038	0.024	0.115	-0.085	0.009
Other	-0.040	0.018	0.027	-0.076	-0.005
Female (Male)	-0.006	0.017	0.734	-0.039	0.027
Pell Received	0.000	0.000	0.589	0.000	0.000
Age Category (<18)					
18-21.99	0.021	0.047	0.648	-0.070	0.113
22-24.99	-0.031	0.053	0.559	-0.134	0.073
25-29.99	-0.036	0.051	0.483	-0.137	0.065
30-39.99	0.004	0.051	0.938	-0.096	0.104
40-49.99	0.056	0.056	0.323	-0.055	0.166
50+	-0.068	0.069	0.325	-0.203	0.067
Block ID (Block 1)					
2	-0.057	0.078	0.460	-0.210	0.095
3	-0.041	0.081	0.618	-0.200	0.119
4	-0.118	0.084	0.163	-0.283	0.047
5	-0.027	0.076	0.721	-0.176	0.122
6	-0.145	0.128	0.258	-0.396	0.106
7	0.109	0.058	0.059	-0.004	0.223
8	0.066	0.054	0.221	-0.040	0.171
9	0.123	0.057	0.031	0.011	0.235
10	0.045	0.057	0.432	-0.067	0.157
11	-0.046	0.056	0.408	-0.156	0.063
12	-0.007	0.050	0.881	-0.105	0.090
13	0.088	0.127	0.485	-0.160	0.336
14	-0.017	0.050	0.739	-0.114	0.081
15	-0.006	0.048	0.906	-0.100	0.089

16	0.016	0.037	0.660	-0.057	0.089
17	-0.182	0.100	0.069	-0.378	0.014
18	-0.114	0.076	0.132	-0.262	0.034
19	-0.105	0.077	0.172	-0.255	0.046
20	-0.089	0.073	0.225	-0.232	0.055
21	-0.079	0.079	0.316	-0.233	0.075
22	-0.090	0.069	0.192	-0.225	0.045
23	0.023	0.053	0.666	-0.081	0.127
24	0.073	0.054	0.180	-0.034	0.180
25	-0.003	0.057	0.965	-0.115	0.110
26	-0.016	0.060	0.784	-0.134	0.101
27	0.028	0.055	0.607	-0.080	0.137
28	0.000	(omitted)			
29	-0.023	0.040	0.570	-0.101	0.056
30	-0.087	0.046	0.059	-0.177	0.003
31	0.000	(omitted)			
Intercept	0.132	0.076	0.085	-0.018	0.281
Var(Int)	4.80E-22	2.19E-21		6.25E-26	3.69E-18

Notes: Observations = 1,714, Course Sections = 80

Summary of Results and Standardized Effect Sizes

Given the wide variety of outcomes examined in the impact evaluation and the complexity of the statistical models, Table 22 summarizes the results found across all analyses. For each outcome investigated, the table includes two key results: the mean difference and the standardized effect size. The mean difference is simply the difference between the treatment and control groups on their means for the outcomes. While these mean differences are easy to interpret given that they are in the unit of the outcome variable, it is difficult to compare the effect of the treatment across outcomes precisely because each outcome is in its own units.

Standardized effect sizes convert these means differences into standardized units. For example, if the mean of the GPA outcome was 2.50 and the standard deviation was 0.50, a standardized mean difference of one would indicate that the treatment increased GPA by one standard deviation, or 0.50 grade points. By standardizing the mean differences, we are better able to compare the size of the treatment effects across outcomes. The calculations for computing effect sizes are slightly different if the outcome is continuous (e.g. GPA) or dichotomous (e.g. credential attainment). Specifically, a statistic called Hedges' *g* is used to compute effect sizes for continuous variables and Cohen's *d* is used to calculated effect sizes

for dichotomous variables. However, these effect sizes are still on roughly the same scale, allowing them to be compared to each other.

A clear patterns emerges when examining the standardized mean differences. The largest effects are found for the outcomes specific to the developmental education courses students enrolled in. The effect size for passing the developmental education course was 0.131 and the effect on the grade students received in their course was 0.092. The effects are more modest, but still important, for the next semester outcomes. The effect sizes for next semester outcomes of persistence, GPA, credits earned, and the percentage of attempted courses that were passed are all between 0.070-0.093. These results suggest that the benefits of being given access to the mobile apps continued into the next semester.

However, these benefits appeared to wane by the following year when examining students attainment of credentials. All of the effect sizes for the credential attainment outcomes were less than 0.05, generally considered a small effect. This finding should be interpreted somewhat cautiously given the relatively short window for examining students attainment outcomes. For example, Cohort 2 enrolled in developmental education courses in Fall 2017, giving them only two years to earn a credential through Spring 2019. In fact, it is somewhat surprising that even 8% of students in the sample did in fact earn associate's degrees by Spring 2019 given the fact that the sample all began in developmental education and had less than three years to complete an associate's degree. It may be the case that differences between the treatment and control groups on credential attainment will grow larger if we examine attainment at a later date. Nevertheless, the results suggest that the intervention had the largest effect on students' short-term outcomes but the effects were more modest on the longer-term outcome of credential attainment. The conclusion will discuss the significance of these results in greater detail.

Table 22: Standardized Effect Sizes for All Outcomes

	Control Group			Treatment Group			Combined Sample				
	N	Mean	SD	N	Mean	SD	*w*	Mean Diff	Pooled SD	Hedges' g	Cohen's d
Continuous Variables											
Dev Ed Grade	1022	1.668	1.486	988	1.806	1.486	1.000	0.138	1.486	0.092	
Next Sem GPA	582	1.87	1.262	598	1.968	1.236	0.999	0.098	1.249	0.078	
Next Sem Course Pass Rate	582	0.66	0.377	598	0.686	0.364	0.999	0.026	0.37	0.070	
Next Sem Credit Earned	869	5.153	5.463	851	5.616	5.429	1.000	0.463	5.446	0.085	
Dichotomous Variables											
Dev Ed Passed	1084	0.513	0.5	1038	0.566	0.496	1.000	0.053			0.131
Next Sem Persist	869	0.67	0.471	851	0.703	0.457	1.000	0.033			0.093
Credential – Any	869	0.15	0.357	851	0.155	0.362	1.000	0.005			0.026
Credential – Associate	869	0.078	0.269	851	0.083	0.277	1.000	0.005			0.042
Credential – Certificate	869	0.136	0.343	851	0.136	0.343	1.000	0.000			0.003

CONCLUSIONS

The literature is clear that students required to complete non-credit-bearing developmental education coursework are extremely unlikely to persist through college and attain a degree, particularly if they fail to complete their developmental education courses. Only 26% of community college students who enroll in developmental education courses and pass all of the courses they attempt earn an associate's degree or certificate within six years, and their completion rate drops to 12% if they do not pass their developmental education courses (Chen & Simone, 2016). At BPCC, only 14% of students who enrolled in a developmental education course during Fall 2012 earned a credential by Spring 2016 (Giani Consulting & Evaluation, 2016). Challenges this great, and students facing such challenges, require bold and innovative solutions.

There is a risk of encountering obstacles anytime an attempt is made to change the status quo. This is particularly true when proposed innovations rely on new technologies to transform practices and processes. It is not surprising that BPCC encountered various challenges while implementing mobile apps for developmental education courses and the IDP, including technical difficulties, confusion among stakeholders over the nature of the initiative, and reluctance to abandon established practices in favor of innovative approaches. Despite these challenges, BPCC was able successfully implement all of the strategies and activities included in the logic model in its FITW application while maintaining buy-in for the initiative among stakeholders, in particular the faculty and front-line staff who are tasked with incorporating these new technologies into their work. Confusion and uncertainty continue to be resolved as faculty and staff become more knowledgeable of the purpose of these approaches and how to effectively utilize these strategies in their practice.

The results of this evaluation provide evidence that the strategies BPCC is employing may be effective at improving outcomes for one of the most disadvantaged student populations in higher education, namely college students unprepared for the rigors of college-level coursework. Although there is an opportunity to increase faculty and student engagement with the mobile apps moving forward, evidence suggests that students given access to the apps outperform their peers in the same developmental education courses. Students in the treatment group were significantly more likely to pass their developmental education (d = 0.131) courses and earned significantly better grades (g = 0.092) compared to students in the control group. Even more, these benefits appear to carry over, as students given access to the mobile apps were more likely to persist to the next semester (d = 0.093) and had better course performance than their peers in the subsequent semester. However, it appears that this effect began to wane over time, as no significant differences were found between the treatment and control groups on the outcomes related to credential attainment, and all standardized effect sizes were less than 0.05, generally considered to be a small effect.

It is important to properly contextualized these results. One way to do so is to compare these findings to other rigorous evaluations of educational interventions. The Investing in Innovation (i3) program was established by the American Recovery and Reinvestment Act of 2009 (ARRA) and administered by the US Department of Education Office of Innovation and Improvement. Sixty-seven grants were awarded through the i3 program, for a total of $679 million disbursed to i3 grantees. These grants included a required third-party impact evaluation that used rigorous methods to estimate the effect of the intervention on student outcomes, such as a randomized controlled trial. Overall, only 18% of the impact evaluations of i3 grants found a statistically significant positive impact on at least one student academic outcome, and only 8% of new interventions supported by i3 Development grants significantly improved

at least one academic outcome (Boulay et al., 2018). Similarly, only three of the 23 evaluations that examined mathematics achievement as an outcome found a statistically significant positive effect, and two of the 23 evaluations found negative effects.

These findings from the i3 program make the results from the present evaluation all the more impressive. Although creating the Open Campus mobile apps required an up-front investment of technology and training, the intervention itself is relatively low-cost, sustainable, and scalable. Even so, the impact evaluation found moderate effects on a variety of students' educational outcomes, including their persistence and academic performance in the next semester in college. This is all the more impressive given that the mobile apps were not designed to be used in subsequent college courses, suggesting that the effects on next semester outcomes were due to the knowledge students had gained and retained from using the mobile apps. Given the significant expense associated with some of the most impactful interventions aimed at improving the outcomes of developmental education students, such as the City University of New York's ASAP program, the results from the present evaluation are promising for other postsecondary institutions seeking to identify sustainable interventions effective at improving the outcomes of students requiring remediation.

Perhaps the greatest barrier to implementation of the mobile apps is that they were not true mobile apps at the time the intervention occurred. BPCC has now released fully functioning Open Campus mobile apps that are downloadable through the Apple App Store and Google Play. The results from the fourth year site visit suggest that students and faculty have more positive perceptions of this version of the intervention compared to the previous version. It appears likely that this version of the intervention will be easier to implement by faculty and easier to use by students, both of which could improve the efficacy of the intervention. Although there are currently no plans to rigorously evaluate this version of the intervention on student outcomes, it will be important for future research to examine whether the fully functioning mobile apps and similar technological innovations can continue to drive improvements in students' college outcomes.

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