Research Note 2019-01

iClicker

macmillan learning

An efficacy study of iClicker: The impact on academic performance

Key Findings

In a quasi-experimental study conducted across four Macroeconomics, two Microeconomics, and two Logic courses, results indicated that:

- iClicker increases student final course grades
- iClicker is even more impactful for students who have a lower baseline level of motivation
- iClicker is most impactful for students who began the course less academically prepared to succeed

Background

The positive relationship between the use of iClicker in the classroom and student final course grades was established through correlational evidence in a mixed-methods implementation study (Baughman, 2018). The data collected in the implementation study allowed for the codification of various use case and subsequently determining the relationship between use cases and student outcomes. The findings provided insights for instructors about how to most effectively implement iClicker in their educational context.

The study, conducted in the fall of 2017, was designed to research implementation, not establish causality, because causal claims only support instructors when the "*why*" behind the impact can be explained - requiring a deep understanding of how the tool is being used. Therefore, once implementation was acutely understood, a quasi-experimental study followed it in the Spring of 2018.

This research note offers an overview of the quasi-experimental, mixed-methods study of the impact of the iClicker engagement model on student academic performance. Results from this study indicate that using iClicker in the higher education classroom increases average end of course grades. Additional analyses suggest that this impact can be explained by an increase in student confidence to participate, engagement in class, and preparedness for in-class exams.

iClicker

iClicker is built on the science of active learning. A synthesis of educational research in the areas of effective active learning, formative assessment, and interactive learning guided the development of iClicker. With its simple, reliable technology and focus on pedagogical content, iClicker makes it possible for instructors to take attendance, engage students in all sized classrooms and lecture halls, and use the student responses to decide which topics to emphasize.

iClicker is a flexible solution that can adapt to an instructor's pedagogical approach. The implementation study identified the "engagement model" as one of the most often implemented approaches. In this model instructors write their own iClicker questions, pose the question to the class and ask them to respond. Responses are used to gauge understanding and spark classroom discussion. Students receive credit for participating in the iClicker activity and in some cases the responses are marked as correct or incorrect. The goal of this model is to increase comprehension and understanding through engagement.

> "my students seem to enjoy using iClicker, it keeps them engaged in a stimulating way."
> *- Instructor*

The Impact Study Design

Instructors who use iClicker as an engagement tool were recruited to participate in the study. In total, eight instructors from four institutions were recruited to participate. One instructor served as her own comparison, one instructor had two comparison instructors, and the remaining instructors were paired as treatment (two instructors) and comparison (two instructors). A comparison of the instructor groups showed they were relatively similar, though iClicker users were slightly more comfortable using technology in the classroom than non-iClicker users (average 5.0 and 3.5, respectively on a scale of 1 = "very uncomfortable" to 5 = "very comfortable") and had fewer years of teaching experience (iClicker users = average of 13 years and non-iClicker users = average of 23 years).

After this study received an exempt status from all appropriate Institutional Review Boards, students were recruited from the participating instructors' courses. In total, 233 students (58%) from courses where instructors were using iClicker (iClicker students) agreed to participate and 123 students from coures where instructors were not using iClicker (non-iClicker students) agreed to

participate (25%). iClicker students were slightly more academically prepared to succeed than were non-iClicker students (3.37 and 3.25 high school grade point average, respectively) and had a slightly higher baseline motivation level (3.62 and 3.38, respectively on a scale of 1-5).

Data analysis

A mixed methods analysis was implemented to study the impact of iClicker on academic performance. Qualitative data captured through classroom observations, student focus groups, and instructor interviews were collected from both iClicker and non-iClicker classrooms. Quantitative data including student and instructor pre- and post-surveys, iClicker implementation data, student usage data, and final course grades were collected from both groups as well.

A hierarchicical linear model was run to understand nested group differences, but the intraclass correlation compbined with small group sample sizes rendered the model inappropriate. Therefore, an analysis of various was implemented through an ANCOVA to determine group differences. The model controlled for prior academic performance, as reported through high school grade point average, and baseline motivation to account for non-randomization of our samples and the difference in group averages.

Results

Results from these analyses indicate that iClicker positively impacts academic performance in the classroom. Results also indicate that the impact is even more significant for students with a lower baseline motivation entering the course and for students who are less academically prepared to succeed.

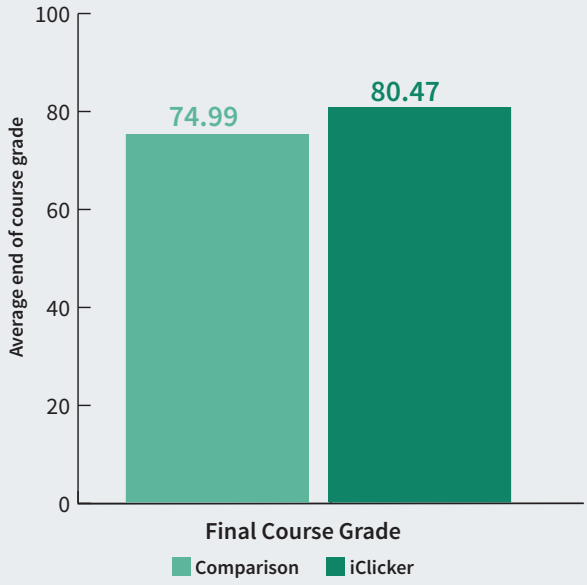
Results from these analyses also suggest that the impact on academic performance may be due to increased in-class engagement as well as iClicker driving instructor-student and student-student discussions, which may be related to increased student comprehension of course material.

iClicker significantly increases end of course grades

Average final course grades were compared between all iClicker students and non-iClicker students. Students who had used iClicker had statistically significantly higher end of course grades (average end of course grade = 80.47) by almost 10 percentage points than students who did not use iClicker (average end of course grade = 74.44).

To account for non-randomization and differences in average level of prior academic performance and baseline level of motivation, both variables were statistically controlled for (R^2 = .19, Adj. R^2 = .17, *p < .05).

Figure 1. Comparison of average end of course grades between all iClicker and non-iClicker students

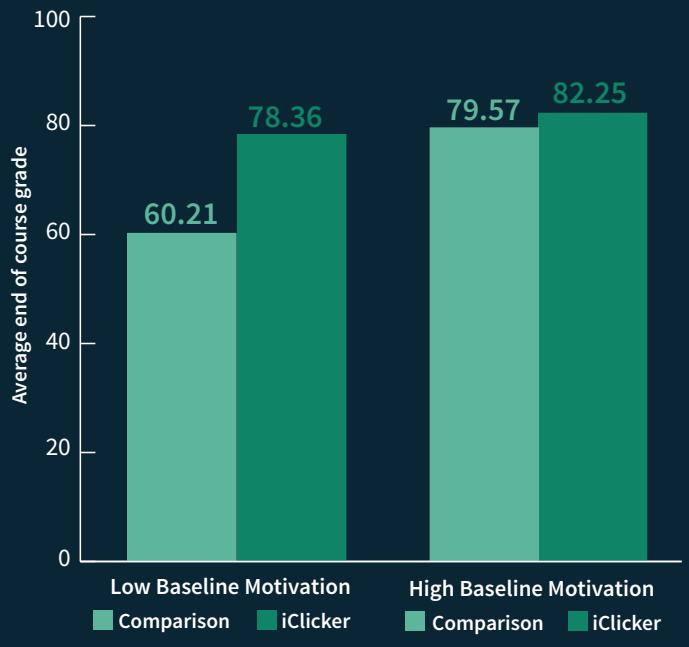


iClicker increases end of course grades for students who are less motivated to succeed and students who are more motivated to succeed.

iClicker was developed on the science of active learning, which engages and motivates students therefore researchers hypothesized that the impact of iClicker would be even more substantial for students who had a low baseline motivation level. Results indicated that iClicker is even more impactful for this subset of students.

iClicker students categorized as "less motivated to succeed in the course" earned significantly higher end of course grades (average = 78.36) than non-iClicker students categorized the same way (average = 60.21). Similarly, iClicker students categorized as "more motivated to succeed" earned significantly higher end of course grades (average = 82.25) than non-iClicker students categrozied the same way (average = 79.57).

Figure 2. Comparison of end of course grades between iClicker and non-iClicker students by baseline level of motivation



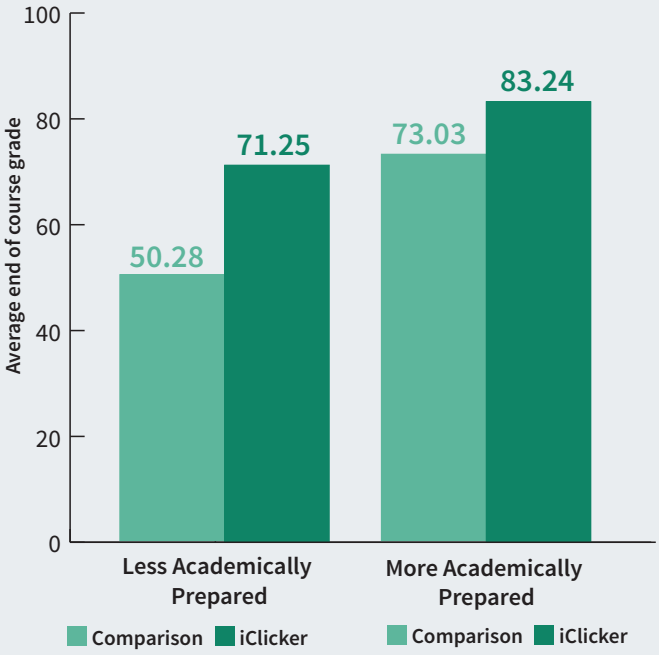
Note: baseline level of motivation was determined based on a set of items on the student pre-survey that asked about student likelihood of attending the course, the amount of time they expected to spend studying for the course outside of class time, and their enthusiasm for the course material. The cutpoint for low and high motivation were established after a statistcal review of the distribution of responses to teh combined varibale

iClicker increases course grades for students who enter the course less academically prepared to succeed

Based on the results of the 2018 implementation study it was also hypothesized that using iClicker would be even more impactful for students who enter the course less academically prepared to succeed, by helping them close skills gaps. Results indicated that it is even more impactful for this subset of students.

iClicker students who entered the course less academically prepared earned significantly higher end of course grades (average = 71.25) than non-iClicker students categorized the same way (average = 50.28). Similarly, iClicker students categorized as "more academically prepared to succeed" earned significantly higher end of course grades (average = 83.24) than non-Clicker students categorized the same way (average = 73.03).

Figure 3. Comparison of end of course grades between iClicker students and non-iClicker students by academic preparedness



Note: academic preparedness was categorized by high school grade point average at graduation as reported by the student on the pre-survey. The cutpoint for less and more academically prepared was a high school grade point average of 3.0

Impact context

Analyses of student and instructor survey data triangulated with observation and interview data suggest that the impacts are due (at least in part) to iClicker courses being more enjoyable, students feeling more confidence to participate in class, students being more engaged in class, and iClicker activities helping them prepare for in-class exams.

> "I'm not one to answer questions in class for fear of being wrong and this allows me to make sure I do understand what's happening without being embarrassed if the answer is wrong".
>
> *-Student*

One item on the post-survey asked students to rate, on a scale of 1 = "strongly disagree" to 4 = "strongly agree" the extent to which they agreed that this course was more enjoyable than other courses they were taking that semester because iClicker was being used. The average rating was 3.5. One student noted,"*Class is more entertaining when I get to use iClicker so I don't mind coming like I do in my other courses*". Further, a sentiment analysis was conducted on one open response item on the post-survey asking students "What are your general opinions of iClicker"? Student sentiment was 0.374 (range -1 to 1) indicating that students have a strong positive sentiment of iClicker.

Results also strongly suggest that iClicker gives students more confidence to participate in class. In addition to a rating of 3.6 (on the same 1-4 scale), "confidence to participate" was noted in 45% of responses to the open response item asking about general perceptions. An example of a representative response is, "*I think it is helpful because you dont have to answer a question out loud but instead answer it via clicker so you don't feel bad about getting the answer wrong*" and another, "*I'm not one to answer questions in class for fear of being wrong and this allows me to make sure I do understand what's happening without being embarrassed if the answer is wrong*".

One item on the iClicker student post-survey asked students to report (on a scale of 1 = "strongly disagree" through 5 = "strongly agree") the extent to which they agree that they were more engaged in this course than in other college courses that they take. On average, students agree (average rating = 4.2) that they are more engaged in the course using iClicker.

Interestingly, a comparison of an engagement scale that was asked on both the iClicker and non-iClicker student post-survey showed no significant difference in the level of engagement between the two groups of students. However, when disaggregated and analyzed by baseline level of motivation, results showed that iClicker student who were categorized as having a lower baseline level of motivation to succeed in the course were significantly more engaged in class (3.70) than were non-iClicker students who were categorized the same way (3.12) suggesting that iClicker is most engaging for students with lower levels of motivation.

One item on the iClicker student post-survey asked students to rate the extent to which they agree that using iClicker helped them prepare for in-class assessments and students tended to either agree or strongly agree that it did (average rating 3.5).

The results from this study, combined with the findings from the 2018 implementation study also provide important insights into the effectiveness of various implementation models and could support professional development. For example, we have learned that the more iClicker questions that an instructor asks in class, the

Amplifying the IMPACT

Our research suggests that trying these strategies may increase the positive impact of iClicker

1. Ask more in-class iClicker questions
this is related to higher final course grades

2. Mark responses as correct or incorrect and incorporate scores into student grades
this drives engagement

3. Share the distribution of results and discuss trends that stand out
this helps to fill skills gaps and correct any misconceptions

4. Explore peer-to-peer discussion of results
this drives engagement and comprehension

higher a student's overall course grade tends to be. We have also learned that instructors who mark the responses as correct or incorrect and discuss the distribution of responses and address any misconceptions realize stronger learner outcomes.

Discussion

The results from this impact study conclude that using iClicker as an egagement tool in the classroom positively impacts student academic performance across Microeconomics, Macroeconomics, and Logic courses. Results further indicate that the impacts are even morepronounced for students who were less motivated to succeed in the course and students who were less academically prepared to succeed.

Understanding implementation is critical to contextualizing impact findings, hence the prioritization of the implementation study conducted 2017. Taken together the results of the implementation study and impact study offer many important insights for instructors. For example, the "deeper" iClicker is integrated into the course experience, the more effective it is as a tool. Students in courses where instructors use iClicker as a participation tool (ie. pose quesions but do not discuss the distribution of responses) realize a relationship with academic performance, but that relationship is much stronger in courses where iClicker is used as an engagement tool (ie. pose questions and discuss the distribution of responses) and even stronger when used as an engagement plus tool (ie. pose questions, discussion responses, and score them as right or wrong). Additionally, the more iClicker questions that are asked over the course of the semester the stronger the relationship with academic performance.

Limitations and future research

The data collected and analyses conducted in this study are strong, however like all applied research there are limitations. Most noteably, the analyses were plagued by missing data. When considering how to handle missingness the Macmillan Learning Impact Research Advisory Council IRAC was consulted with. Various imputation methods were presented, but they ultimately advised to remove the students with missing data from the ANCOVA, limiting our sample. Additionally, it can be argued that a hierarchical linear model would have been more appropriate to run due to nesting within classrooms, but again the IRAC suggested that due to sample sizes and variability that could be attributed to nesting they advised an ANCOVA.

Research on whether, why and for whom iClicker impacts outcomes is ongoing. Implementation studies are currently being replicated in a broader set with educational contexts with a broader set of instructors and students. And, the impact of specific features of iClicker, like the attendance feature are being researched in current experimental efficacy studies to better understand the impact of individual components. Additionally, a replication quasi-experimental study is planned for Fall 2019 to address the limitations in this study and increase generalizability. Together, the results from this growing body of research will continue to provide actionable evidence to support all instructors and their students to achieve more.

Ethics and Data Privacy

Prior to data collection, this study and the associated consent forms and instruments were reviewed and approved (found exempt) by the Human Resources Research Organization (HumRRO). HumRRO is an accredited third-party Institutional Review Board (IRB) organization with no affiliation with Macmillan Learning. Macmillan Learning also adheres to any local IRB requirements at participating instructor's institutions. The data in this study, which are provided by the instructor and consenting students, are initially identifiable. However, once a random identifier is generated identifiable data are destroyed. Data are provided in secure storage locations, and access is permitted only to the Primary Investigator in the study and the Co-Primary Investigator for quality assurance of match and analysis.