



Research Brief with iClicker Reef, 2018-01

# RESEARCH BRIEF

## How iClicker Reef implementation decisions relate to student outcomes

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### Introduction and Background

In order to provide instructors and other faculty the most valuable and actionable evidence of how a digital tool will work for their students in their educational environments, evaluation of product effectiveness needs to begin in development and continue throughout the lifetime of the product. By beginning testing early in a product's life cycle, instructors have valuable insights they can use when making adoption and implementation decisions. This research brief presents the results from an implementation study of iClicker Reef and provides a discussion about how this study will provide early evidence of effectiveness to support instructors when they make adoption and usage decisions.

### iClicker Reef

With its simple, reliable technology and focus on pedagogical content, iClicker makes it possible for instructors to take attendance, engage students in even the largest classrooms and lecture halls, and use the students' responses to decide which topics to emphasize. In 2014, the iClicker team introduced Reef Education (now called iClicker Cloud), a mobile-optimized, cloud-based classroom engagement solution that gave instructors a choice between a clicker-based infrared system and one students could access through a computer, smartphone, or tablet.

### Implementation Study

Thus far, numerous iClicker Reef case studies have been conducted. The results of these studies have been descriptive in nature. Therefore, the goal of this study is focused on advancing the research portfolio that supports iClicker Reef by providing a correlational study. A quasi-experimental study has been underway and will be released in fall 2018.

We invited instructors from various educational contexts to use iClicker Reef for a complete semester. The mode (whether students used remotes or mobile devices) was the instructor's choice. During these implementation studies, we documented implementation and collected systematic data on the user experience and student and instructor outcomes. We learned what product effects can be observed in specific settings with deeply understood contexts and evaluated whether identified use cases relate to learning outcomes. The study design and methodology have been outlined below, as well as the findings and implications.

**Note:** This is an abbreviated version of a technical report which provides a more complete discussion of the research design, methodology, and results. To access the full report, please visit <http://www.macmillanlearning.com/catalog/page/learningscience>

**Methodology.** Comprehensive data from instructors and students were collected for a mixed methods analysis.

**Institution and instructor sample.** In total, six instructors from five public institutions were recruited to participate. Two of the instructors taught at a moderate-sized four-year institution in the Midwest, one instructor taught at a large four-year institution in the Midwest, one instructor taught at a moderate-sized two-year institution in the West, one instructor taught at a large four-year institution in the Southeast, and one instructor taught at a large four-year institution in Northeast Canada. One instructor in the sample (17%) had been teaching for more than 15 years, four (67%) had been teaching between six and 15 years, and one (17%) had been teaching for under five years. There was variation regarding how comfortable the instructors felt using technology (responses ranged from “very uncomfortable” to “very comfortable”) at the beginning of the semester. The majority of the instructors indicated that they planned to use iClicker’s polling features and believed that their students primarily valued the interactivity iClicker provides.

**Student sample.** Participation in the study and its data collection activities were completely voluntary. Students could opt to participate in the overall study and still opt out of any data collection activity. Of the 2,142 students registered in the study courses, 731 (34%) consented to participate in the implementation study. Of the 731 students who consented to participate, 645 students opted to complete the baseline survey and 371 students opted to complete the end-of-term survey.

Of the students who opted to complete the baseline survey, 41% reported they were comfortable using digital tools in the classroom and 85% agreed that digital tools could enhance their learning in class. The students who consented to participate in the study seemed to be moderately motivated, with 49% indicating that they expected to spend more than 6 hours a week outside of course time studying and 57% indicating that they planned to attend every class without exception. Sixty-one percent of the students who opted to complete the end-of-term survey were female. The majority of the students who took the end-of-term survey were also freshman (61%), followed by sophomores (23%), juniors (11%), and seniors (2%), respectively.

**Data collected.** Comprehensive data were collected for a mixed methods analysis. Student and instructor surveys were administered at the beginning and end of the semester, and instructor classroom observations were conducted midsemester along with a formal instructor interview protocol. Product use data and student academic performance data were collected. Data were matched across sources, and descriptive and correlational analyses were conducted.

**Findings.** Findings from the implementation study suggested that there is a positive relationship between using iClicker Reef and student learning, that instructors and students find iClicker Reef easy to use, effective in helping student stay engaged, and promotes active learning in the classroom.

**How is iClicker Reef being used within and across educational environments? What are the motivations for use cases? Is there a difference in use by type of mobile device?**

six instructors across five institutions used iClicker Reef in this study. Five of the six instructors were members of STEM departments and taught STEM courses (physics, chemistry, biology, or math), while one instructor taught psychology. In this section, we have presented implementation across educational environments followed by implementation across instructors.

Of the six instructors in the study, two instructors allowed their students to access iClicker Reef in the classroom with any device available to them—an iClicker remote, mobile device, or a laptop. Two instructors allowed iClicker remotes and mobile devices but preferred that laptops not be used. Two instructors allowed mobile devices and laptops but did not allow iClicker remotes to be used.

Across the instructors, a mean of 276 ( $SD = 94$ ) iClicker questions were asked during the semester. The amount of questions asked across instructors varied with one instructor asking only 139 questions and another asking 438 questions. Of the questions presented to students, an average of 7 ( $SD = 5$ ) were answered each session across instructors; there was an average of 1 to 18 questions presented per session. Students answered a mean of 67% of the questions presented each session. Instructors used multiple-choice questions the most frequently (75%), followed by numerical (14%), short answer (8%), and target questions (3%).

Students primarily accessed iClicker Reef through a mobile device or laptop (61%), followed by the iClicker remote (30%). Eight percent of students used a combination of devices. Of the students who reported using either a mobile device or laptop, 60% used a mobile device, 20% used laptops, and 20% chose not to say which device they used. For students who used a mobile device to access iClicker Reef, 69% used an iPhone, 23% used an Android, and the remainder used some other mobile device. There was no evidence of any difference in iClicker use based on type of mobile device used. Students were able to equally participate in polling across device types. One instructor reported being limited to certain types of iClicker questions because some students used iClicker remotes; students who used iClicker remotes could not respond to target questions.

All instructors tried to use iClicker Reef during each class and were largely successful with the exception of the classes held during the first and second weeks of the semester when students were still registering. Four of the six instructors used iClicker Reef strictly to track student participation credit. Students were required to respond to iClicker questions and received credit for participating that day if they did, which ultimately contributed to a certain percentage of their grade; depending on the instructor, participation credit accounted for 5–20% of the students' final course grade. These instructors may have coded correct and incorrect answers in the iClicker Reef system, but the instructors did not require that students answer the questions correctly to receive participation credit. One instructor required that students answer questions correctly in order to receive credit. This instructor calculated the amount of correct iClicker responses over the course of the semester and turned the score into a quiz grade. One instructor used iClicker to track participation and measure the accuracy of the students' responses. Ninety percent of the students' iClicker Reef score was earned by simply responding to the question, while 10% of the score was earned by responding correctly.

All instructors indicated that they used iClicker Reef for classroom polling. During classroom observations, the majority of the instructors shared the graphs displaying classroom results despite the fact that most of the

instructors did not score responses. The graphs were used to show students how their responses compared to their classmates, to generate classroom discussions, or to provide additional support from the instructor when needed. Two instructors also used iClicker to track attendance. Neither of these instructors was using the geolocator feature when they submitted the survey.

### **How is use of iClicker Reef related to student learning, student engagement, and student satisfaction with the course? Is there variability across different use cases?**

There was a statistically significant positive correlation (.226) between use of iClicker Reef and student learning. Use of iClicker Reef was quantified by the number of questions that students answered over the course of the fall 2017 semester. Student performance was measured by the students' final course grade in percentage form. The positive correlation, although low, indicates that students who answer more iClicker questions have higher course performance. Conversely, students who answer fewer questions tend to have lower course performance.

A second correlation was calculated using either a combination of number of iClicker questions answered correctly (for the two instructors who scored iClicker questions) or number of questions answered (for the other four instructors who did not score) and student performance. This correlation was also statistically significant and higher at .376. The higher correlation likely indicates the importance of quantifying use of iClicker by the type of use expected in each classroom (e.g. if students only receive credit for correct responses then quantify by number of correct responses, if the instructor only calculates the number of responses then do not score answers, etc.).

A 23-item student engagement survey, the Student Course Engagement Questionnaire (SCEQ), was administered during the last three weeks of the semester via SurveyGizmo. The survey represented four factors of student engagement: skills (engagement through practicing skills), participation and interaction (engagement through participating in class and interacting with the instructor and other students), emotional (engagement through emotional engagement with class materials), and performance (engagement through levels of performance in the class). Students responded to the items using a Likert Scale of 1–5 (ranging from “not characteristic of me at all” to “very characteristic of me”), and responses were totaled to calculate a student engagement score. The student engagement score was correlated with the students' final course grade. There was a positive, statistically significant correlation of .253 between student engagement and course performance. While the correlation was relatively low, it indicates that students who rate themselves as more engaged tend to have higher course grades.

A 16-item student satisfaction survey was also administered during the last three weeks of the semester via SurveyGizmo. The 16 items were derived from a 23-item survey that measured student perception of clickers as an instructional tool to promote active learning in the classroom and student satisfaction with clickers in their class. There was a very low correlation (.072) between student satisfaction and student course performance. The correlation indicates there is no discernable trend in how satisfied students are with clickers

and their course performance. The data were also analyzed by the instructors.

### What iClicker Reef question types are being asked in class, and what is the variability in learning performance based on question types?

**Table 1. Question Types by Instructor/Course**

Instructor/Course	Multiple-Choice	Numerical	Short Answer	Target	Correlation of Usage to Learning
University of Central Florida: Introduction to Psychology	85%	0%	8%	7%	.557
Boise State University: Physics I	79%	21%	0%	0%	.539
Boise State University: Physics II	83%	17%	0%	0%	.433
University of Waterloo: Introductory Cell Biology	100%	0%	0%	0%	.209
University of Wisconsin-Eau Claire: Physical Science	100%	0%	0%	0%	.511
University of Wisconsin-Eau Claire: General Physics	100%	0%	0%	0%	.145
Merced College: Introductory Chemistry (8 a.m.)	48%	25%	22%	5%	.735
Merced College: Introductory Chemistry (9 a.m.)	49%	25%	21%	5%	.735
Merced College: Intermediate Algebra	46%	36%	14%	4%	.802

The Merced instructor had the most variability in types of questions asked and also had the highest correlations of use of iClicker Reef to student performance (.735–.802). Two of the three instructors (the University of Waterloo instructor and the University of Wisconsin-Eau Claire General Physics instructor) who strictly used multiple-choice questions had the lowest correlations to learning performance (.145–.209). However, one instructor who strictly used multiple-choice questions (the University of Wisconsin-Eau Claire Physical Science instructor) had a moderately high positive correlation to learning performance (.511). The two instructors who primarily used multiple-choice questions but also mixed in other types had moderately high correlations as well (.433–.557). While the design of this study does not permit causal inferences to be drawn, the general trend of higher correlations associated with varied types of questions and lower correlations associated with strictly using multiple-choice

questions is interesting to note. The one instructor who strictly used multiple-choice questions and had a moderately high correlation also scored questions whereas the other instructors who used strictly multiple-choice questions did not score questions. Perhaps this explains how the instructor achieved a high correlation to learning while strictly using one type of question.

**Is use of iClicker Reef to facilitate class interaction (i.e. asking opinions, soliciting feedback) associated with a different relationship to student performance as compared to using iClicker Reef for formative assessment (i.e. actually testing the students' knowledge)?**

**Table 2. Instructor Choice of Formative Assessment Usage and Student Learning**

Instructor/Course	Formative assessment	Correlation of usage to learning
Merced College: Intermediate Algebra	Yes	.802
Merced College: Introductory Chemistry (8 a.m.)	Yes	.735
Merced College: Introductory Chemistry (9 a.m.)	Yes	.735
University of Central Florida: Introduction to Psychology	No	.557
Boise State University: Physics I	No	.539
University of Wisconsin-Eau Claire: Physical Science	Yes	.511
Boise State University: Physics II	No	.433
University of Waterloo: Introductory Cell Biology	No	.209
University of Wisconsin-Eau Claire: General Physics	No	.145

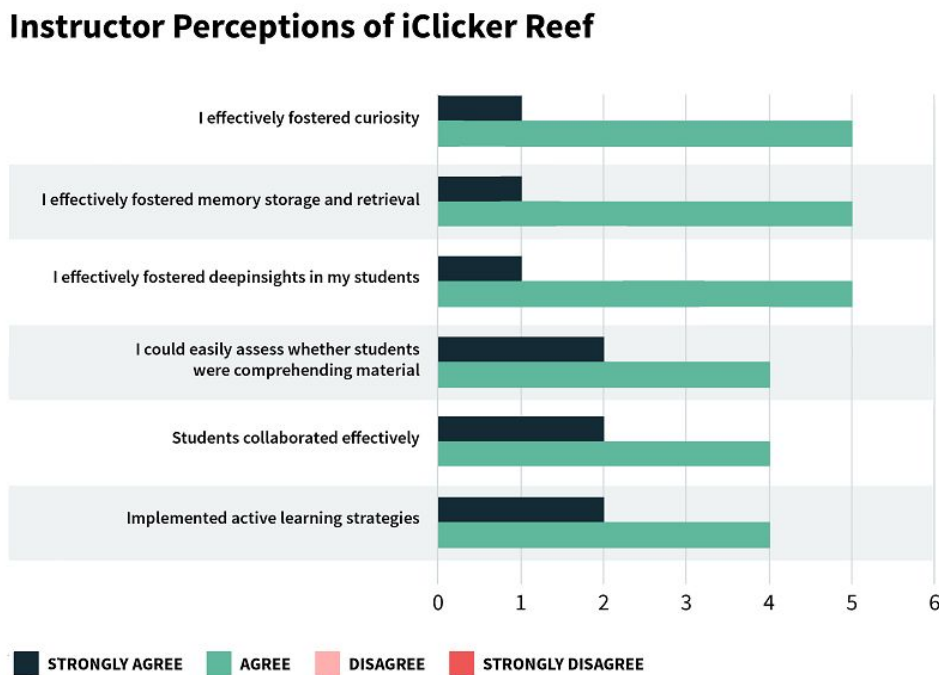
The Merced College instructor, who taught chemistry and math, was the only instructor in the study who used iClicker questions as a quiz grade. The other instructor who scored items only devoted 1/10 of a point for accuracy and the other 9/10 of the point was credit for answering the question regardless of whether the response was correct. The four remaining instructors did not score items or consistently share the correct answers with students during class. Table 2 shows that the Merced instructor had the highest positive correlations between use of iClicker Reef and student performance when compared to the other instructors. The instructor who offered 1/10 of a point

for accuracy also had a moderately high correlation to learning; however, this correlation was lower than the two instructors who did not use iClicker for formative assessment.

### What are instructor and student perceptions of iClicker Reef?

Instructors were generally positive in their perceptions of iClicker Reef. All instructors “agreed” to “strongly agreed” that iClicker Reef helped foster student curiosity, memory storage and retrieval, and deep insights. In addition, the learning tool helped instructors easily assess student comprehension and encouraged student collaboration and active learning.

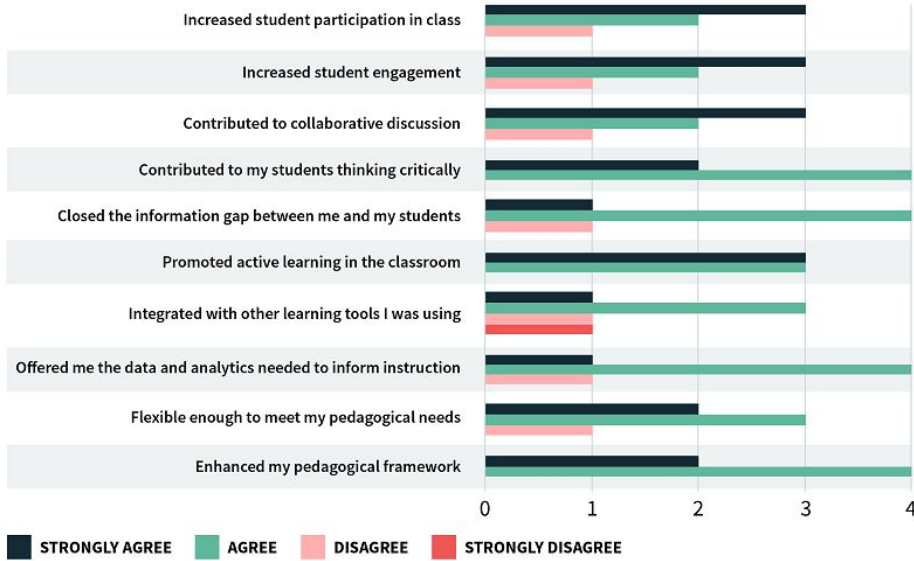
**Graph 1. Instructor Perceptions of iClicker Reef**



The majority of the instructors also agreed that iClicker Reef helped facilitate active learning in the classroom and student engagement (see Graph 2). One instructor did not approve of using mobile devices in the classroom. The instructor felt that use of mobile devices in the classroom has the potential to distract students because they can access other websites on those devices instead of paying attention to the lecture. In future semesters, the instructor will consider allowing students to only use iClicker remote devices to avoid this potential distraction. All instructors agreed that iClicker helped students think critically, promoted active learning in the classroom, and enhanced their pedagogical framework.

**Graph 2. Instructor Perceptions of iClicker’s Contribution to Active Learning**

### Instructor Perceptions of iClicker’s Contribution to Active Learning



Instructors were asked via an open-ended question the most effective way to use iClicker. The majority of the instructors used the learning tool to stimulate discussions with their students so they could understand if students understood the content presented to them. One instructor reported using the tool to simulate the type of questions that would appear on exams in order to better understand student mastery of topics depending on question type (i.e. multiple-choice, open response, etc.) and level of reasoning (i.e. Bloom’s Taxonomy Scale) expected.

All but one instructor reported that iClicker Reef was easy to use and that they liked to use it frequently. Instructors were also asked to rate iClicker Reef via the Net Promoter Score (NPS). The NPS is an index ranging from -100 to 100 that measures the willingness of customers to recommend a company’s products or services to others. Given the NPS range of -100 to 100, a score above 0 is considered “good,” a score above 50 is considered “excellent,” and a score above 70 is considered “world class.” The instructors in this study rated iClicker Reef at a NPS of 16, which is considered “good.”

Student feedback about iClicker Reef was also generally positive. Students took an end-of-semester online survey to measure ways of using iClicker Reef in class, engagement and satisfaction with the course, ease of use, and their general perceptions of iClicker Reef.

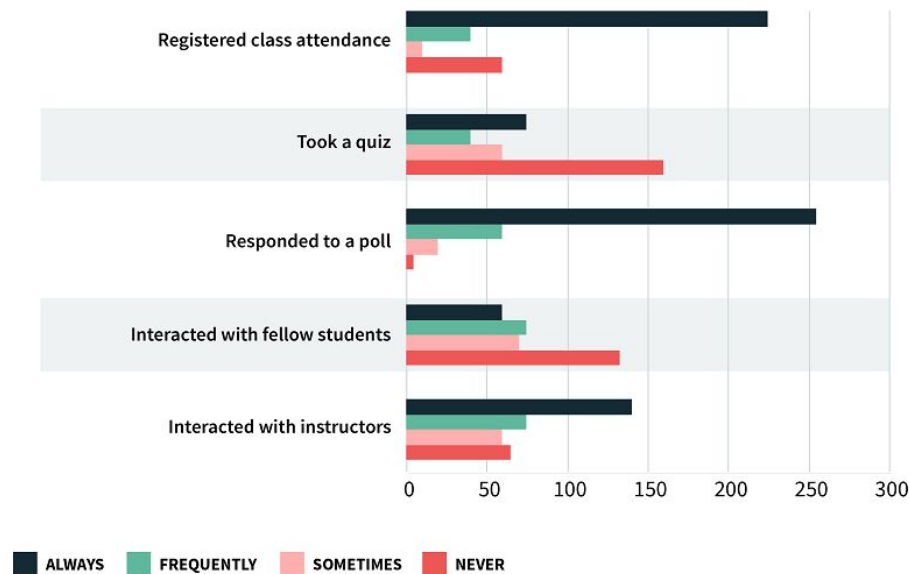
Students reported that they used iClicker Reef in class for a variety of activities, including registering class attendance, taking quizzes, responding to polls, and interacting with fellow students and their instructor. The majority of students indicated that they always used iClicker Reef to register their attendance in class and to take a



poll. Fewer students used iClicker Reef to take quizzes and to interact with fellow students. Graph 3 shows the frequency of the students' responses by class activity.

**Graph 3. Use of iClicker Reef for Class Activities**

### Use of iClicker Reef for Class Activities



The survey results indicate that students were satisfied with their course and iClicker. On a 4-point scale (“strongly disagree” to “strongly agree”), student mean satisfaction was 3.15 ( $SD = 0.55$ ) meaning students “agreed” to “strongly agreed” that they were satisfied with their course.

The engagement scale rated student engagement on four factors as well as tracking overall engagement. The four factors were as follows: skills engagement, emotional engagement, participation and interaction engagement, and performance engagement. Students rated statements on a 5-point scale ranging from “not at all characteristic of me” to “very characteristic of me.” Overall, students reported that they were moderately engaged in their class.

Students were asked to rate their level of engagement with the class specifically due to using iClicker Reef on a scale of 1 (“not at all engaged”) to 4 (“very engaged”). The average rating was 2.7 which indicates that students were “somewhat engaged” to “engaged.” Students were then asked to rate their level of engagement compared to other courses they were taking during the semester on a 5-point scale (“less engaged than in other courses” to “a lot more engaged than in other courses”). The average rating was 2.9 which indicates that students had about the same level of engagement in the course using iClicker Reef as in other courses.

Students considered iClicker Reef to be easy to use. The System Usability Scale was administered to students at the end of the semester. Students rated iClicker Reef 72.69 on the scale. Scores above 68 points are considered “above average” in terms of system usability.

When asked to report their favorite use of iClicker Reef through an open-ended question, 19% of students reported that they enjoyed using the learning tool for questions and answers. Twelve percent reported that they enjoyed polling, 8% enjoyed taking quizzes, and 7% enjoyed checking their retention of information. A couple other notable activities were reviewing practice questions (5%) and answering sample questions for their exams (4%).

Students were also asked to report their least favorite use of iClicker. Twenty-seven percent of students reported that there was nothing they did not like, 13% reported that the question was not applicable, 9% reported that they did not enjoy taking attendance with iClicker, 6% reported connectivity issues or technical problems, and 6% reported that they did not enjoy taking quizzes.

**Implications.** There is a positive relationship between using iClicker Reef in the classroom and student learning. Students who answered more questions are associated with higher course grades than students who answered fewer questions. Instructors that score iClicker Reef questions tend to have the highest correlations to student learning. In addition, the instructor who both scored questions and used a variety of item types had the highest correlations across all instructors. Instructors believe that iClicker Reef helps engage students and promotes active learning in their classrooms. Instructors and students believe iClicker Reef is easy to use.

**Limitations.** The sample was limited to six instructors and 731 consenting students. Although the sample size was appropriate for the analyses completed, the generalizability of the findings is limited to instructors and students similar to this sample. Additionally, all analyses are descriptive or correlational and therefore are not meant to infer causation.

**Future research.** The findings from this study have contributed to the ongoing improvement of iClicker Reef. To measure impact of iClicker Reef on student learning, a quasi-experimental study is under (spring 2018 semester). That study will contribute to the research supporting iClicker Reef and enable causal inferences to be made about the effectiveness of iClicker Reef on student learning.