GOING BEYOND CLICKERS: USING A VERSATILE WEB-BASED RESPONSE SYSTEM FOR ENGAGING AUDIENCES IN COLLEGE CLASSROOMS AND IN PUBLIC SCIENCE EVENTS

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Abstract

Large introductory biology classes and public science events, such as small science cafés have the same goal: bridging the gap between the presenter and the audience to convey the information while being engaging. The authors compare old school (clicker) and new school (digital) audience engagement technologies in a large biology course at Cornell University and in a public science event (Science Cabaret) in Ithaca, NY, USA. The Investigative Biology course was designed for biology majors to provide lab experience with emphasis on the processes of scientific investigation and to promote collaboration, communication, and literacy in science. Science Cabaret is an Ithaca, New York-based science café with the overarching goal to enhance the public's understanding of scientific discoveries and to increase science literacy in the community. In the past decade students purchased “clickers” for their courses to be able answer multiple-choice questions, clicking on the correct letter on their hand-held device. These clickers became the cornerstone of flipped and engaged learning by turning lectures into dialogues, allowing the presenter to become a facilitator rather than a "sage on the stage". In Investigative Biology at Cornell University we used this system for multiple years and faced many challenges, as students did not know if the instructor registered their answers, they forgot to bring the clickers, or gave the clickers to their classmates who answered instead of them. Rapid technological developments, especially the increase of computing power opened up new opportunities, moving these systems from a clicker device onto cellphones and laptops, starting the Bring Your Own Device (BYOD) movement in pedagogy. These web-based real-time audience engagement systems allow presenters to have dialogues with the audiences, assess their knowledge, ask multiple-choice questions, create word-clouds and have them write clarifying comments to identify challenges. The opportunities are endless, as participants can click on a map or biological pathway, brainstorm about an idea, rank concepts, or ask questions. The flexibility and mobility of these systems gave the opportunity for audience engagement outside of the classroom. Public science events using BYOD could step away from the lecture format and involve the audience in a more effective way. The online access makes these response systems scalable, bringing the strength of formative assessments and surveys to public science communication events, journal clubs or distance learning. In addition to the new opportunities, online polling systems create new challenges for the presenters, as allowing students to use mobile devices in the classroom can be distracting. The authors of this poster compare a web-based real-time response system called Poll Everywhere to iClickers, highlighting the benefits and the challenges of both systems, and discussing user habits in large classrooms and in a small science café. In conclusion, the authors observe that the benefits of web-based response systems outweigh the challenges, and this form of digital pedagogy is becoming indispensable in the classroom and other learning environments.

Keywords: audience engagement, science communication, science café, large classroom, formative assessment, engaged learning, public science events.

1 INTRODUCTION

Public science events, such as science cafés and large college-level introductory courses have a very similar role: communicate scientific information to audiences in a clear, concise and easily understandable way. Instead of using classical lecture format, both public science events and large college courses have been adopting modern, pedagogical techniques, promoting active learning [1]. These events want to make sure that their audiences critically evaluate the information they receive, they participate in a conversation with each other and the presenters, as it has been shown to help deep learning [2, 3]. This can be challenging, as many courses and public science events have several hundred audience members. The rapid evolution of classroom technologies helped presenters engaging these larger audiences, and at the beginning of the 21st century clickers became a widely
used response system [4, 5, 6]. Presenters can use these clickers to ask multiple-choice questions from the audience if audience members purchased the required clicker device and the presenter had access to a receiver. Data from these response systems can be downloaded and answers can be matched up with the names of the registered clicker users [4, 5, 6]. This technology fundamentally changed the way presenters communicated with the audience, and answers collected in-situ could be used for formative assessment [7] and presenters could make ad-hoc changes to their presentations based on audience response. A second breakthrough in educational technologies was the appearance of web-based response systems [8]. The increased ownership of smartphones, and faster wireless data connections [9] gave rise to the Bring Your Own Device (BYOD) movement [10]. Technology companies, such as Reef Polling, Learning Catalytics, Web Clicker and Poll Everywhere started to provide services for audience engagement using tablets, laptops and cell-phones.

The authors of this paper have engaged audiences in large introductory biology classes at Cornell University in Ithaca, NY (www.investigativebiology.cornell.edu) and at a science café called Science Cabaret (www.sciencecabaret.org), also located in Ithaca, NY in the United States of America. The course instructor of the Cornell biology course and the curator of the science café have been collaborating to improve audience engagement through technology, presenter training, audience assessment and undergraduate student involvement. The real-time web-based response system provides a foundation of further assessment of the audiences in both of these science events (large classroom and science café). Using audience engagement technology undergraduate students from Cornell University will help assess the impact of this science café on community learning. The objectives of this paper were to evaluate a real-time web-based, BYOD audience engagement system as it was used for formative assessment of students in large classrooms and surveying public science event attendees in science cafés. The web-based system is compared to the traditionally used clicker system to highlight its benefits for broader audience engagement.

2 METHODOLOGY

Digital audience engagement systems were assessed in a science café called Science Cabaret (www.sciencecabaret.org) in downtown Ithaca, NY, USA and in a large introductory biology class called Investigative Biology (www.investigativebiology.cornell.edu) at Cornell University.

Science Cabaret was established in Ithaca, NY in 2005, helping local scientists disseminate science to the public. The overarching goal of Science Cabaret, the monthly science café in Ithaca, NY, is to enhance the public’s understanding of scientific discoveries and to increase science literacy in the community. Ithaca’s Science Cabaret was inspired by the Cafe Scientifique movement, which started in Europe in the late 1990’s and has spread rapidly. Cafes Scientifiques are informal talks in bars, cafes and other public venues that give like-minded people a chance to discuss current and sometimes controversial topics in science. In Ithaca the authors of this paper co-curate an event one Tuesday a month. The event is held in a local bar, and is open to the public. Attendance can range from 60 people to a175 people at these events. This digital polling system was tested in order to collect information from the audience, gain information about their user habits, and pave the way of future science literacy assessment of the audience. Science Cabaret with the help of Engaged Cornell (www.engaged.cornell.edu) will connect the community and Cornell undergraduate students, and these web-based response systems will assist students to gather information about the influence of Science Cabaret on the science literacy education of the attendees.

The Investigative Biology Laboratory Course at Cornell University is designed for biology majors to provide lab experience with an emphasis on the processes of scientific investigation and promote collaboration, communication, and literacy in science. Students gain scientific skills and instrumentation techniques used by biologists to construct new knowledge. Course topics include genetics, evolution, microbiology, ecology, biochemistry, and molecular biology. Audience engagement technology has been used in this course to connect the instructor to the 400+ students in the lecture. The goal of the authors were to turn the lectures into a dialogue to promote deeper learning.

Students who enrolled in the Introductory Biology course at Cornell University in 2009-2010 purchased personal response devices called iClicker remotes (https://www.iclicker.com), designed to answer in-lecture multiple-choice questions. The instructor used a computer-connected receiver, provided by the iClicker company. Setting up the receiver in the classroom was quick and simple. Students registered their own devices online, as every individual device had its own code. By registering, students authenticated their code to their names. The instructor received answers from the students, and
downloaded these answers from the receiver. At the end of the semester the class roster and the registration list were synched with the answers, and students could receive credit for their answers. Only multiple-choice questions could be asked, but the instructor could decide whether points were awarded for participation or for the correct answer. On their remotes, students were able to choose A, B, C, D or E as a correct answer, and see the summarized class response on the projected screen. Students could see whether their response was registered, but could not see their response histories.

Between 2012 and 2016, students used BYOD technology with the Poll Everywhere (https://www.polleverywhere.com) web based interface in the Investigative Biology Laboratory course, with a 432-student enrollment. Students did not have to purchase a separate device, but they needed to bring a phone, a smartphone, a laptop or a tablet to answer questions. In addition to answering multiple-choice questions, instructors could ask open-ended questions and the answers could be listed as a text-wall, word cloud, cluster, or ticker. Students could rank answers, or the instructor could show an image, such as a picture of the brain, and students needed to click on the correct part of that picture to answer a question. In the Q&A the students could also submit questions and vote on each other’s submissions. Example questions along with the detailed type descriptions can be found on the Poll Everywhere website (https://www.polleverywhere.com/how-it-works).

Questions were inserted into presentations and projected on a screen or shown in a web browser on the attendees’ devices. The class had a unique URL where students entered their answers online. Students using texting received a phone number where they sent their answers as a text. Poll Everywhere has a user-friendly application that students can download from the app store and see the questions on their own devices, or even Tweet their answers during any live polling event. Students can instantly see whether they answered the questions correctly, and the answers remain in their response histories. Students must log in before every lecture to allow the instructor to connect their answers to their names.

Poll Everywhere was also tested in 2015 in Science Cabaret. This science café attracts a lay audience, and audience members can be assessed and surveyed through Poll Everywhere; it is free for up to 40 participants. Audience members can use their cellphones to text, or they can use the web browser or the app on the smartphones to answer the questions. Participants were able to answer questions without logging in, and therefore remained anonymous.

Both iClicker and Poll Everywhere questions require the presenter to set-up the questions prior to the presentation, decide how many times audience members can answer and whether they receive any credit for their answers. Data about the devices used to answer poll questions was collected in Spring 2016 (n=323) in Investigative Biology at Cornell University and in 2015 in Science Cabaret (n=52).

3 RESULTS

After over eight years of using iClicker and Poll Everywhere to engage audiences in classrooms and at a variety of science events, we evaluated and compared both systems. Their detailed comparison can be found in Table 1.

The evaluation of the web-based polling system user habit in Science Cabaret showed that 69.3% of the audience members used their web-browsers, and 30.7% used texting to answer the questions. None of the audience members carried a laptop or a tablet to the event, or downloaded the app onto their phones (Fig. 1.). In the Investigative Biology classrooms 6% of the students texted their answers using SMS through their phone providers, and only 2% used a tablet. The majority of the students (51%) used a laptop, while 42% used a smartphone, with 31 of the 42 % preferring the Poll Everywhere application to an internet browser.
Table 1.  Comparison of clickers (iClicker) and web-based response systems (Poll Everywhere). iClickers were used in large classrooms in 2009-2011, while Poll Everywhere was used 2012-2016.

<table>
<thead>
<tr>
<th>Category</th>
<th>Clicker</th>
<th>Web-based response system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
<td>Separate device necessary</td>
<td>Existing device</td>
</tr>
<tr>
<td>Question type</td>
<td>Multiple-choice</td>
<td>Multiple-choice, Open-ended, Q&amp;A, Ranking, Clickable</td>
</tr>
<tr>
<td>Location</td>
<td>In-class</td>
<td>In-class, Public Science Events, Distance learning, Homework</td>
</tr>
<tr>
<td>Response history</td>
<td>No instant feedback</td>
<td>Response history with correct answers visible online</td>
</tr>
<tr>
<td>Technology</td>
<td>Receiver is required</td>
<td>Strong Wi-Fi and/or phone service required</td>
</tr>
<tr>
<td>Cheating</td>
<td>One user with multiple devices</td>
<td>Answering in-class questions outside of classroom</td>
</tr>
<tr>
<td>Distraction</td>
<td>none</td>
<td>Social media and non-class related websites</td>
</tr>
<tr>
<td>Technical difficulties</td>
<td>Student did not register device</td>
<td>Student forgot to log in before answering questions</td>
</tr>
<tr>
<td>Price per student (in 2016)</td>
<td>~42 USD (purchased to own)</td>
<td>~14 USD (annual subscription fee)</td>
</tr>
</tbody>
</table>

Figure 1. Percentages of the audience using devices and application to engage with the presenter via a web-based response system called Poll Everywhere in the classroom of the Investigative Biology Lecture (n=323) and in Science Cabaret science café (n=52).

4 CONCLUSIONS

Audience engagement is a key to successful science communication in both classrooms and in public science events, however it can become challenging with very large number of attendees. The rapid development of classroom response systems from iclickers to BYOD allows presenters to reach larger audiences, however understanding the benefits of these systems, and how the audience members use them is a key to successful presentations.
4.1 iClickers vs. Web-based systems

The appearance of iClickers fundamentally changed the pedagogy in large classrooms and helped the movement of flipped classrooms, where students complete their coursework outside of the classroom and use the lecture time for discussion and engagement [5, 11]. Since specific devices are needed for both the instructors and for the audience members to be able to use clickers, this technology stayed in the academic classrooms (Table 1.). Presenters can use clickers to complete formative assessments using multiple-choice questions, and hence change their presentations according to the answers of the audience. These answers however are only visible to the audience members if the presenter shows them, and the members of the audience will not have access to them later. Since a single clicker device is registered for each audience member, the loss of that device can result in administrative challenges, especially if students receive a grade for their answers. If students forget to register their devices, the instructor does not know who answered the question, and therefore the system cannot be used for individual assessment. Regardless of these challenges, iClickers have provided a strong technological support for the rise of modern pedagogical techniques and engaged learning for a decade [4, 5, 6].

The rapid evolution of mobile devices provided a solution for many of the challenges the students and the instructors faced with iClickers. In the United States 92% of students owned a smartphone in 2015 [9] and the decreasing smartphone prices helped a broader audience to have mobile access to the internet in- and outside of the classroom [12]. This rise of digital pedagogy made it inevitable to see separately purchased clickers being replaced by already owned cellphones, laptops and tablets, starting the Bring Your Own Device (BYOD) movement (Table 1.).

Web-based systems opened up opportunities for new ways to engage audiences. Using the open-ended questions, ranking, and picture click format, Investigative Biology instructors wrote new case studies for the lectures, had the students approach problems in a unique way, and thus encouraged creative and critical thinking by going beyond multiple-choice questions. The survey function in Poll Everywhere was actively used for data collection, getting feedback from the students and creating take-home quizzes. BYOD technologies increased the use of peer-instruction by asking students to explain a biological phenomenon to their neighbor [11], reflect on what they learned, and identify the most complicated, muddiest point in the lecture.

The easy accessibility of the web-based polling system helped audience engagement move outside of the classroom. While clickers needed to be purchased by the audience members in advance, BYOD technology scales to the size of the audience and venue. The authors have been using Poll Everywhere in a science café held in a restaurant in downtown Ithaca, NY, USA. Attendees of this science café can be assessed about their understanding of a certain topic before and after the presentation, they can be surveyed about their opinions or they can provide short feedback that can trigger further discussions. Web-based engagement technologies scale even further, as they can engage audiences in Massive Open Online Courses (MOOCs) and in other forms of distance learning [13].

Another benefit of web-based systems is the accessibility of previous questions by the audience members. Students in a classroom or science café attendees can revisit their answers later in their response histories, and continue the conversation based on those questions outside of the venue.

Due to the web-based nature of the BYOD platforms, it requires the presence of either a strong Wi-Fi network or cell phone provider data network. This is not a great challenge in classrooms in the United States of America [9], but can certainly limit the use of this technology in public science events or in countries where data networks are not accessible everywhere. Since audience members are using their own mobile devices to answer questions and engage with the presenter, they can be distracted by unrelated texting, web surfing or social media access.

Since digital mobile devices are now part of our everyday lives, we should take advantage of them in education, science communication and audience engagement from small public science events through large classrooms. Clicker technologies were limiting large audience engagement to classrooms, but with a device in everyone’s pocket, public science events, such as science cafés can expand how they engage and assess their audiences. This technology allows the authors to involve Cornell students in audience assessment of the science café in Ithaca, NY, USA. With the support of an Engaged Cornell grant, students will attend Science Cabaret and assess audiences using both Poll Everywhere and other methods.
4.2 User behaviour in Public Science Events and Large Classrooms

The evolution of web-based real-time response systems opened up an opportunity for both college instructors and science café organizers to engage large audiences. Since the technology relies on the devices being used by audience members, it is important that the user habits are well understood. The fundamental difference between in-class use and other venues is the planned use of electronic devices. While in a classroom students expect the instructors to use a web-based polling system, attendees of a public science event may not carry their laptops or tablets with them. This was reflected in the results of the surveys that the authors of this paper conducted in the Investigative Biology lectures and in Science Cabaret (Fig. 1.). Most Cornell students used the internet browser on their laptops to answer Poll Everywhere questions, while there were no laptops used by audience members in the science café on the days of the surveys. A large proportion of students and science café attendees used their smartphones to answer questions, however while most students downloaded the Poll Everywhere application to their smartphones, science café attendees used the web-browser on their phones. In class only a small proportion of the students use texting via SMS, that was widely used in the public science event. These differences in user habits between a planned use in a class and an ad-hoc use in a public science event highlights the strength of these web-based real-time audience response systems. They are incredibly scalable, and can be used from small meetings through large lecture halls, with or without previously informing the audience about it.

In addition to their ability to be used in a wide variety of venues, web-based response systems provide an opportunity for the presenters to assess their audiences, collect demographic information about the attendees, receive feedback during a presentation and adjust their messages or presentation styles accordingly. This new audience engagement technology provides the backbone to digital pedagogy as iClickers did for flipped classrooms over a decade ago. It is our duty to embrace this technology and help communicate scientific information to audiences from public science events through large classrooms.

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REFERENCES


