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Angel Hoekstra & Stefanie Mollborn

Department of Sociology, University of Colorado, Boulder, USA


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How clicker use facilitates existing pedagogical practices in higher education: data from interdisciplinary research on student response systems

Angel Hoekstra* and Stefanie Mollborn

Department of Sociology, University of Colorado, Boulder, USA

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This article identifies how clicker use can support or augment existing principles of good teaching across different disciplines in higher education. While many of these principles will be familiar to instructors, the link between student response system (SRS) use and existing pedagogical methods is still often unclear, even for scholars who are well read in the literature. Functioning as a resource for both novices and instructors who have already incorporated clickers into their courses, this article synthesizes existing literature and offers empirical data from five courses in three disciplines to show how SRSs can be used to support contemporary pedagogical goals. The authors discuss five exemplary practices, providing sample clicker questions along the way, to show how clickers can be used to facilitate active learning in large courses.

Keywords: student response system; classroom communication system; clicker; scholarship of teaching and learning; teaching with technology; higher education

Introduction

In recent years, access to higher education has become increasingly available in many developed nations. Approximately 40% of all young adults in the USA were enrolled in a two- or four-year college in 2008 (Fry 2009). College and university enrollment grew by more than 20% in many OECD countries from 1990 to 1997, and graduation rates in Norway and the UK exceeded those of all other nations at 35% in 2000 (Henry 2000). Because many colleges and universities are now admitting the largest incoming classes that administrators have ever seen, institutional pressure for faculty members to teach larger courses is greater than ever. Larger enrollment can result in learning environments that are less conducive to comfortable and productive learning (McKeachie 2002; Hoekstra 2008), and some claim that the ‘large-class-lecture-centered approach

*Corresponding author. Email: angel.hoekstra@colorado.edu

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(encourages) student disengagement’ (Cooper and Robinson 2000, 6). In response, many instructors are seeking pedagogical tools that promote student engagement and can be used to effectively facilitate learning techniques in large courses that have traditionally worked well in smaller classes.\(^1\)

Student response systems (SRSs), or clickers, represent a teaching technology with the potential to help instructors achieve many contemporary pedagogical goals in larger classes. A clicker is a small handheld device that, when combined with effective pedagogical strategies, can be used to promote critical thinking and discussion in a learning community. Clickers allow students to answer a question by pressing a button, and software on the instructor’s computer collates and displays a histogram of responses. Depending on how a teacher structures his or her pedagogical approach to clicker use, SRSs can be used to support a variety of teaching and learning goals (see http://www.cwsei.ubc.ca/resources/SEI_video.html for videos demonstrating exemplary clicker use).

Without careful attention to pedagogical strategies, however, clicker use may not benefit classroom instruction (Kennedy and Cutts 2005; Stowell and Nelson 2007). While instructors in many countries (e.g., Australia, Canada, China, New Zealand, the UK, and the USA) have used clickers for several years, at present, many faculty members still know little about SRSs. For instructors who have heard of clickers but have yet to see the technology in action, skepticism may seem a natural response to the notion of adding an additional (technological) component to an already busy workload.

This article reviews existing literature showing how SRSs can be used to facilitate five existing principles of good teaching in higher education: (1) eliciting student feedback, (2) identifying students’ preconceptions and assumptions about course material, (3) facilitating opportunities for small- and large-group discussions, (4) improving social cohesion in the learning community, and (5) gathering anonymous data from students to support conceptual application. We provide data from five courses at a large university to support our assertion that clickers can be used to facilitate many existing pedagogical techniques, rather than necessitating a radical change in teaching practices. After describing how instructors have engaged in each of these practices without clickers, we suggest how clickers can be used to support or improve on these pedagogical techniques.

Designed to benefit both novices and faculty with some experience using clickers, this article details some basic pedagogical functions of SRS. We cannot provide a comprehensive overview here, but for two great introductory resources, see Bruff (2009) and Banks (2006). As a tool, an SRS can be used in a variety of ways. Empirical research has shown some pedagogical strategies to be effective and others less so (Turpen and Finkelstein 2010). While we address a few contemporary pedagogical models (Mazur 1997; Duncan 2005; Mollborn and Hoekstra 2010), other approaches exist and some instructors may find it helpful to consult a discipline-specific pedagogical model for clicker use.
Methods

The multi-method data were collected from five courses in three disciplines (astronomy, chemistry, and sociology) at a large university in the western USA from 2004 to 2009. Four courses were of lower level (general chemistry, lower division astronomy, and two lower level sociology courses), and the fifth was an upper-level sociology course. Each enrolled 50–450 students, and all courses used the same SRS (www.i-clicker.com). While each instructor took a different approach to clicker use, some of the pedagogical models were quite similar and all encouraged peer discussion of clicker questions. Some of these courses were taught by the authors, so human subjects approval was gained for all components of this research. Much of the data are anonymous, all were kept confidential, and students were informed that they could opt out of participation at any time.

Data on the effects of SRS use took four forms. Survey questions were used to gather demographic information and to assess students’ perceptions of the effects of clickers in all five courses. Excepting the upper-level sociology course, the first author conducted participant observation to gain a sense of how clickers were being used similarly and differently in each course. Students were asked to complete one-page anonymous free writes about their experiences with clickers in all five courses. This method helped identify any problems or concerns about clicker use that students may not have felt comfortable discussing in qualitative interviews. Students were interviewed (N = 38) about the effects of clickers for learning and interaction in the introductory sociology and general chemistry courses.

Practice 1: gathering student feedback to improve teaching and learning

Student feedback can be collected to gain information about teaching practices or learning behavior, but the purpose of collecting feedback is to foster reflexive critical thinking about the learning process. Feedback can be used to improve on course structure or specific pedagogical methods, and asking students to provide anonymous feedback elicits their participation in shaping the learning community. Instructors can effectively gather anonymous data from students (Freeman, Blayney, and Gine 2006) by means of clicker questions. While SRS can be used in both small and large courses, they permit efficient gathering of large amounts of data, which particularly benefits instructors teaching large courses.

Existing methods

The most common method for collecting student feedback – end-of-term course evaluations – is helpful for the preparation of future courses but useless for improving a course during the semester, so many instructors develop their own methods. For example, an instructor might ask students to
offer brief feedback on note cards midway through the term (Angelo and Cross 1993). Alternatively, more in-depth information can be gathered by asking students to evaluate aspects of the course through an in-class writing assignment. While these methods gather anonymous data useful for improving teaching and learning, it is time consuming to read and summarize so much information.

**Benefits of using clickers**

Useful feedback can be gathered from students more frequently, ‘on the fly’, or regularly during the semester through clicker questions. SRS use makes collecting and interpreting students’ responses less time consuming, and unlike paper-based methods, clicker data provide immediate feedback useful for formative assessment. Students can see their own and their peers’ responses, and productive group discussions can be held about why the students answered as they did. For example, the following clicker questions were used in sociology courses to gather anonymous feedback:

When I do a reading assignment for a class like this one, I focus most on

(A) Learning the numbers and statistics presented
(B) Understanding the main ideas and conclusions
(C) Analyzing the strength of the argument/study design
(D) Connecting ideas and findings to other readings
(E) Considering broader implications of ideas and findings

What do you think about the balance between social psychological theory and applied information on friendships/relationships as used in this class so far?

(A) The balance is about right
(B) I would prefer more social psychological theory
(C) I would prefer more on friendships/relationships
(D) Do not know/other

Observation notes confirm that both of these questions prompted productive discussions about teaching and learning in the course. In an interview, a student told us about the advantages of using clickers to gather and display information about students’ study habits, as in the first sample question above: ‘It helped me to see more clearly what [the professor] thought was important from that day’s reading’.

Whether addressing course design or teaching practices, clicker questions can be used to solicit student feedback to improve the learning environment. Furthermore, use of clicker questions to solicit feedback communicates to students that they should be thinking critically about the learning process. In the following quotes from anonymous free writes \((N = 257)\), sociology students
confirm that clicker questions can help students to think critically about their role in the learning process:

I like how [clicker questions] force me to think about the material that has just been presented, instead of just writing aimlessly throughout class . . . I think it is important to see what the rest of the class is thinking on the issues presented.

[Clickers are] a fantastic way to encourage students to read the readings, come to class, and participate. It is a great way to use positive reinforcement [to] help us understand major [concepts and] themes.

Clicker questions provide an efficient means for gathering student feedback, and when used effectively, they can help to strengthen both students’ and the instructor’s commitment to maintaining a productive learning environment.

**Practice 2: identifying students’ assumptions or preconceptions about course material**

In almost all disciplines, students enter the classroom with ideas or assumptions that can hinder the learning process (Duncan 2005). In natural science courses, for example, students sometimes draw on inaccurate preconceptions about what they think they know from the ‘real world’ and try to apply them to course material. When this information contradicts what they must learn to succeed in a course, problems can arise (see the example given below). Similarly, in social science and humanities courses, students often maintain inaccurate and potentially problematic assumptions (e.g., compared with physics, English should be easy), cultural ideas (e.g., racial discrimination no longer exists), or stereotypes (e.g., most students who take a sociology of drugs course use illegal drugs). When students enter a course with inaccurate or unfounded ideas that can hinder learning, it benefits the entire learning community to identify and critique/correct them.

**Existing methods**

A wide variety of methods are used to collect information about the preconceptions and assumptions students hold. ‘Ice-breaker’ exercises, short surveys, or holding a group discussion in the initial weeks of a course are common. In the chemistry course studied here, the instructors regularly used a background knowledge quiz (Angelo and Cross 1993) in the initial weeks of the course to help students determine whether they had the basic skills (e.g., algebra) needed to succeed. However, in large courses or those that meet infrequently, in-class time is limited and instructors may give up on tailoring a course to students’ needs, potentially resulting in a less effective learning environment.

**Benefits of using clickers**

Clickers can be used to gather information about students’ views, assumptions, or behavioral expectations that may affect teaching and learning. Compared
with hand raising or distributing and analyzing a survey, clickers provide an anonymous and efficient way of collecting data about what students expect and/or what they know (whether correct or incorrect) about the material. Clicker questions can be written before or even during class, allowing the instructor to obtain feedback as the need arises.

Professors in the two natural science courses studied here regularly used clicker questions asking students to predict the outcome of in-class demonstrations. The purpose of this practice is twofold: (1) to engage students in the upcoming demonstration by predicting what will happen beforehand and (2) to identify any preconceptions or inaccurate information that might hinder students’ learning. One clicker question used in the astronomy course asked students to predict ‘how many marbles (representing small planets) could fit into the size of this rubber ball (representing our sun)’. After students responded and the demonstration revealed that many answers were incorrect, a group discussion was held. This clicker question encouraged students to think about the ratio of volume to surface area, but it also helped the instructor to determine how many students were following their intuition rather than the formula. In anonymous free writes \( (N = 73) \), astronomy students wrote that regularly applying course concepts through clicker questions is ‘a good way for students to see if they are understanding the concepts’ and ‘helps [students] know what they need to work on’.

Clicker questions can be used to show the learning community the nature of their preexisting values and beliefs. Clicker histograms visually depict students’ views and can be used to engage students in critical discussion. In one of the sociology courses studied here, the instructor used anonymous clicker questions to depict how many young adults in the class actually used drugs/alcohol to excess. Following an initial discussion of stereotypes about ‘what kinds of people usually take a drugs course’, clicker questions were used to reveal the actual levels of drug-using behavior among the students. When the clicker data revealed that many of the students in the course used drugs responsibly or not at all, a discussion was held and students critiqued the stereotype. In a survey question \( (N = 27; 77\% \text{ response rate}) \), 92% of these students agreed that clicker use ‘fosters more lively and realistic discussions about drug use’ than would be the case with traditional methods alone.

While gathering and displaying information on trends in students’ behavior could be useful in any course, this method is particularly useful for courses featuring sensitive material (Mollborn and Hoekstra 2010). Though students’ responses are always anonymous to each other, having them trade clickers or using an anonymous response option permits full anonymity. The anonymous nature of the data makes it safer for students to admit to unpopular views, and clicker histograms often support the argument that a diversity of responses exist in the learning community. In our observations, when students saw that others shared their views and/or that they are not the only one holding a minority view, they became more likely to speak up and share their reasoning. Thus, effective pedagogical use of an SRS can generate more diverse discussions.
Anonymous free write data collected over several semesters from the two lower level sociology courses ($N = 456$) suggest the benefits of using clickers to reveal students’ preexisting expectations and foster critical thinking:

The discussions after seeing the clicker data made me consider other people’s opinions.

More people seem to pay attention when multiple voices are being heard in class.

[Clicker questions] are useful for comparing our class views to the typical norms in society, to see if those norms are changing.

Many students enter college courses with preconceptions about course material and/or their peers’ behavior. Clicker data can help to clarify or correct these assumptions.

For example, the following question was used in a sociology course to help students better understand their own and others’ attitudinal preconceptions about gender:

What do you think is the level of gender inequality in contemporary America?

(A) Basically no inequality
(B) Only a little inequality
(C) Some gender inequality
(D) Quite a bit of inequality
(E) I don’t know/other

Students were asked to answer this question independently, and then a group discussion was held to clarify and critique the students’ beliefs about gender inequality. In a free write, one sociology student wrote:

I was very impressed by how useful and relevant the clickers were. [T]he questions concerning the class’ opinions of the material or their personal experiences were quite revealing. Every day I was surprised to find out what [my] classmates thought and had done. I feel these questions opened up discussion quite a bit and allowed us to explore certain issues more in depth.

In summary, clicker questions can be used in many disciplines to tailor teaching and learning to the needs of the student group. Viewing and discussing students’ aggregated beliefs, expectations, or misconceptions can help instructors increase efficacy in the learning environment.

**Practice 3: supporting conceptual application and critical thinking through small- and large-group discussions**

Traditionally, discussions are used in a variety of ways to support teaching and learning. Depending on the discipline, course material, and teaching
philosophy of the instructor, exercises that encourage peer talk can be used to varying degrees. While discussions are common in (smaller) seminar courses, they can be difficult to facilitate in large lecture halls. Yet, peer discussions can foster critical thinking conducive to learning (Smith et al. 2009). Giving students ‘time to talk things through’ helps them to think critically, weigh options, and consider alternative lines of inquiry, all with peers at similar levels of cognitive ability. While many instructors use peer talk exercises for in-class application, others value discussion, because it offers opportunities for rapport development in face-to-face interactions.

**Existing methods**

We describe two common methods used to facilitate productive small-group discussions. In the first approach, the instructor designs an in-class assignment and students are asked to form groups. Each group receives instructions specifying the tasks and/or materials needed to complete the work, and students are instructed to take notes as they discuss the material to ensure group accountability. While beneficial for critical thinking and rapport development, this approach can be time consuming to design and implement. In the second approach, students work in consistent, regular peer groups throughout the semester to apply concepts, evaluate theories, critique course material, etc. When students spend a significant amount of time working with the same peers over the term, they get to know their group members and can consult them outside of class if needed. Two difficulties with this approach are ensuring equitable group member participation and determining what to do when group members are absent.

Concerns common to small-group work also affect the facilitation of large-group discussions. Beyond the challenges involved with engaging a large number of students in verbal participation, large-group discussions can be difficult to monitor. Instructors who successfully get peer talk going may worry whether students who are not directly participating are still engaged as well as about how to direct the discussion to include multiple viewpoints rather than hearing only from a vocal minority.

**Benefits of using clickers**

Clicker questions can be used to support productive discussion in both small- and large-group formats. First, SRSs permit each student to have his or her own ‘voice’ when clicking in (see below). Second, when a clicker question solicits an opinion or past experience (i.e., does not feature a single correct answer), the anonymity of clicker responses encourages honesty. Students can respond however they wish, and when the votes are displayed, the diversity in the group’s responses provides an excellent ‘jumping off point’ for critical thinking.
and discussion (Mollborn and Hoekstra 2010). One free writer from the sociology course on drug use ($N = 199$) wrote:

It was fun to look at the results and see where people stood on the drugs they have tried, especially for me because I have never tried illegal drugs. I barely drink as it is, and seeing that there were other people [in the class] that didn’t either, I was like, ‘Yay! I’m not the only one’, and I didn’t feel left out, especially being in a college setting.

Clicker responses visually depict for students the diversity that commonly exists in the learning community, and their use facilitates participation for those who usually remain silent during class discussions.

Another common practice in SRS use – awarding additional points for correct answers to clicker questions – motivates students to engage in the learning process. In one popular pedagogical approach, Peer Instruction (Mazur 1997; hereafter PI), students are directed to answer clicker questions on their own first, before engaging in peer discussion of course concepts. The PI method encourages students in large science courses to think about the problem and its component parts first before turning to peers to ‘convince each other of their answer’ (Crouch and Mazur 2001, 970). While this approach encourages peer discussion for the benefit of all learners, it does so within the context of first teaching students how to assess and evaluate conceptual material on their own. Many instructors who use PI award additional points for correct answers: this encourages students to read the course material before class and to take clicker questions seriously. However, students may become more focused on getting the correct answer than learning the course material, a problem which has incited some instructors to begin awarding all responses an equal number of points (James, Barbieri, and Garcia 2008).

Recent research suggests that peer talk ‘enhances understanding, even when none of the students in a discussion group originally knows the correct answer’ (Smith et al. 2009, 122). Survey data from four consecutive semesters of the chemistry course studied here support the value of peer discussion. In the survey ($N = 814$), 75–80% of the students indicated that clicker-prompted peer discussions were at least ‘somewhat helpful’ for learning, and 45% said that these discussions were ‘quite’ or ‘extremely’ beneficial. Similarly, in anonymous free writes, students in the astronomy course ($N = 73$) cited the two most common benefits of clickers for learning as (1) helping students determine whether they are understanding course concepts and (2) fostering engaged, active participation in class.

Survey data collected from students in one of the lower level sociology courses also suggest that students find clicker-prompted peer discussions beneficial for learning. In this course, 90% of the students over two consecutive semesters ($N = 155$) reported being given opportunities to discuss course concepts through clicker questions ‘sometimes’ or ‘very often’. Of this sample, 68% said that past experience clicker questions were ‘somewhat/very useful
for helping me to think and learn’, and 69% felt that critical thinking clicker questions were ‘somewhat/very useful’ for learning. These question types are designed to promote conceptual application and critical thinking through peer talk, either in small groups or among the entire class (see Mollborn and Hoekstra 2010). In summary, clickers can be used to enhance the effectiveness of small- and large-group discussions in a variety of disciplines. When used appropriately, SRS data can help students to see both what they have in common and how they differ. This encourages more students to contribute, enhancing diversity in discussion.

Practice 4: Fostering social cohesion in the learning community

The term social cohesion describes when the members of a group identify with and/or and feel a sense of emotional attachment to one another. When a group or learning community is cohesive, its members are more inclined to feel accountable to the group and to work to achieve group goals. Behavioral research suggests that attraction to a group and its members, liking group members, and wanting to stay in the group provide evidence of social cohesion (Forsyth 1999).

Peer talk exercises are useful for facilitating social cohesion, because they allow students to interact frequently in a social environment that is conducive to learning, encouraging feelings of community, cohesiveness, and sharing (Festinger, Schachter, and Back 1950; Lawler 1999). When students feel more integrated into a learning community, they are more likely to feel valued as participants who have something to contribute. Peer talk exercises (e.g., small groups and research teams) also promote cohesion by strengthening student accountability for completing role behavior. Research suggests that emotional attachment to peers in college is predictive of academic success (Fass and Tubman 2002), so increasing social cohesion may have positive implications for academic achievement. When students feel more tied to the learning community, they are more likely to read before class and to engage with the learning process (Hoekstra 2009).

Social psychological research suggests that social cohesion is more likely to form in intimate settings (Carron and Spink 1995), such as in small interactive classes. Social cohesion is less likely to form in large courses where students do not get to know one another and the instructor may not know their names. However, research supports the use of team-building and cooperative exercises to build cohesion in larger groups (Carron and Spink 1995). Facilitating learning through peer interaction offers students opportunities to form cohesive social bonds (Weimer 2002), both in small groups and within the larger learning community.

Existing methods

Instructors currently use several strategies for building cohesion. ‘Ice-breaker’ activities, often used at the beginning of a term, are designed to build rapport for
the purpose of forming a safe and productive learning community. Applied and hands-on activities (e.g., field trips and group presentations) make use of shared experiences for the purpose of building cohesion. Research projects that require undergraduates to meet with peers outside of class can also teach students to work cooperatively and to hold peers accountable for shared work.

**Benefits of using clickers**

Clicker use fosters cohesion in several ways. First, by viewing clicker data over time, the group *develops shared knowledge of its members* (e.g., how well others are doing; what peers think). The following example illustrates that shared knowledge gained through clicker questions can lay a foundation for group solidarity. In a section on social stratification, sociology students were asked two successive clicker questions:

Which of the following social positions has the greatest status/esteem in the USA?

(A) CEO of Wal-Mart  
(B) President of the USA  
(C) Attractive and popular socialite (e.g., Paris Hilton)  
(D) Attractive, highly paid actor or actress (e.g., Brad Pitt)

Which of the following social positions has the least status/esteem in the USA?

(A) CEO of Phillip Morris Tobacco  
(B) Convicted CEO who stole from pensions at Enron  
(C) Homeless man who was born into a poor family  
(D) Homeless single mother who lost her job due to drug addiction

*Discuss: Why did you choose the answer you did?*

These clicker questions address differential access to power, esteem, and wealth, a difficult topic for some students. Generating a strong, productive discussion of this topic can be challenging, particularly in a large course.

The slides displaying these questions asked students to consider what they took into account when responding. Students were encouraged to discuss their reasoning in pairs, the clicker data were revealed, and a class-wide discussion was held. Unlike the use of a narrative or photos illustrating stratification, the use of clicker questions here engaged the students as a cohesive group. Seeing the histograms of their peers’ responses promoted ‘on-the-spot’ critical discussion, and verbal participation was quite strong (and a wide variety of views were respectfully considered) during the ensuing large-group discussion. Overall, observational data suggest that using clicker questions in this way fostered social cohesion through shared knowledge, as some students
referred back to the class’ responses to this set of clicker questions in future class discussions.

The display feature of an SRS – its capacity to efficiently and publicly display information about students – suggests a second means by which SRS use fosters social cohesion: by giving each student a voice. Clicker questions generate data about the group, about ‘us’, that have shared meaning. In this way, clicker use creates a participatory culture where ‘everyone has a vote, and every vote counts’. Bruff (2009, 100) explains

Polling students about their opinions and experiences, and sharing those results with the class, help[s] students get a better idea of who their peers are. This can help students to engage in small group and class-wide discussions that are more respectful, [because they are] founded on a better understanding of the participants of those discussions.

Sharing and learning information about each other through clicker histograms, then, fosters ties that can bind students more strongly to the learning community. When learning a difficult concept, students may feel relieved to see that others in the class are also struggling. The following quotes from free writes and interviews confirm that clicker use can promote social cohesion:

Using clickers ... made the class feel more personal, as you could actually see people’s opinions, anonymously and immediately. I really enjoyed the ‘safe’ feeling to the learning environment.

I liked being able to talk without talking. Clickers allowed me to say what I thought without having to compete with other students for a turn to say what I felt.

The use of clickers gave me a chance to express my opinion. I am shy and don’t like to speak in front of large groups, so using clickers gave me the opportunity to feel like I contributed to class discussions.

Interview data suggest that many students felt that using clickers helped them to participate even without speaking up, while observational data confirm that the use of clicker questions spurred high levels of verbal participation in the courses studied here.

Data from the two natural science courses illustrate a third way in which clickers can foster social cohesion: by breaking the class into smaller, more cohesive groups. Observational data confirm that students in the chemistry and astronomy courses often formed regular clicker groups comprising three to six students. Many of these groups were retained throughout the semester, and interview data suggest that many students developed familiarity and social cohesion with peer group members. An interviewee from the chemistry course describes working in her clicker group:

I like the people I am working with a lot . . . [Using clickers] gives us some time to chat in class and see how each other are. And, there was a week . . . I had a really
hard week, just personally I wasn’t doing so well and I wasn’t caught up in the class. They noticed it and they were like, ‘Hey is everything going okay? You seem like you are kind of behind’. I was like, ‘Yeah ... Okay, so by this Friday, I will have read up to this chapter ... so you guys ask me on Friday’. And they did, so it’s definitely been beneficial in accountability, because we can tell if one of us is not prepared for class because then we won’t know how to answer the [clicker] questions.

Regular clicker group participation provided individual students with the following benefits when answering clicker questions in the chemistry and astronomy courses. First, group members helped one another to better understand course material through talk. Second, they often held one another accountable for completing homework and/or reading before class. Third, students sometimes used verbal and non-verbal interactions (e.g., knee/arm pats and ‘high fives’) to build cohesion useful for maintaining the group over time. While the above quote suggests that clicker use can foster cohesion in regular clicker groups, the following quote — provided by an astronomy student in a free write — suggests that SRS use can also strengthen cohesion in the larger learning community:

At first I hated the clicker, I thought it was just a piece of equipment we were being forced to [buy] ... but I’ve come to realize they’re an integral part of the class. Right from the first day, [the instructor] said how the clickers would be used. [He] asks us clicker questions about the reading, or to apply concepts or express our opinions. I would never really [have] talked to the people next to me if not prompted to through clickers. In other classes I’ve had in this room, I’ve felt completely separate from the class and the material, but thanks to clickers, I feel involved.

Whether clicker questions have a single correct answer or are being used to spark discussion/debate, the data they generate communicate information to students about their classmates. This knowledge is shared and retained over time, facilitating cohesion in the learning community.

Practice 5: collecting data from students to support theory testing, conceptual application, and group discussion

While the previous four practices likely apply to learning in many disciplines, the fifth has greater applicability for courses in which students’ beliefs or experiences represent actual data that can be used for exploring course topics. In some disciplines, collecting real-time, anonymous data from students offers a powerful tool for testing hypotheses and spurring group discussion. For example, one of the sociology instructors collected anonymous data on students’ voting patterns and used it to drive critical discussion about political participation. While instructors can gather information fairly quickly in smaller classes, data collection is time consuming in large courses.
Existing methods

Paper surveys are a common approach for gathering anonymous data about students’ experiences. The weaknesses of this method include having to wait until the next class session to use the results and overcoming some students’ beliefs that instructors may manipulate the data to prove their point. In another approach, the instructor asks students to write anonymously and then has them crumple up their responses and throw them up front. This method permits discussion of students’ responses on the same day, but time constraints restrict reading too many aloud. While fun, this approach is also less environmentally friendly, as the responses must be cleaned up afterward. Physical actions can also be used to depict behavioral or experiential trends in a student group. Here, the instructor asks students to raise a hand or stand in response to a question (e.g., ‘Of those eligible to vote in this election, please stand if you voted’). While this approach enables in-class comparison of the students’ responses on that same day, it precludes anonymity: everyone can see how others respond, potentially biasing responses.

Benefits of using clickers

Anonymous data about students’ beliefs or experiences are perhaps most efficiently gathered through clickers. While responses are limited to quantitative answers, clicker responses can also be compared to those of other demographics (e.g., displaying national samples depicting high-school graduation rates next to the data collected from one’s students). This method was used in all three of the sociology courses studied here. By juxtaposing comparable data sets, students are encouraged to think critically about course concepts and/or demographic trends. In interviews ($N = 38$), students said that they often felt more engaged by data that came from their peers than by data from other sources. One sociology student explains:

[Clicker questions] show where everybody’s at and give us real specifics. We read statistics in books all the time, [but] where are they getting their information from? Who are their subjects? We are sitting in this classroom right now, discussing this question, and the clicker [histogram] is giving us real data [useful for discussion].

This comment confirms what many others said in interviews: clicker response data are engaging and can support critical thinking. When large-group discussions are dominated by a small subset of voices, students may assume that the views being discussed are representative of most people in the class. SRS use alleviates this problem by depicting clearly the diversity that often exists.

Next, SRS can be used to foster ‘on-the-spot’ theory testing. Clicker questions which gather information about students’ past experiences generate data that can be used to push students to apply theories to real-world scenarios. For example, before discussing theoretical explanations for the gender gap in
pay, one sociology instructor asked students which of their parents earned more income when they were growing up. The clicker data collected from this large class supported traditional norms, with the majority of these students' fathers earning more than their mothers. A discussion was held, and students considered several potential reasons for the gender gap in pay. Surprisingly, interview data suggest that students often feel more convinced of the validity of theories by testing them in class rather than reading about them in textbooks. The following quotes convey this theme:

It was very interesting and sociologically beneficial to see the percentages of the class that fit into various categories. Although the sample of kids that ‘clicked in’ is not representative of the larger population, it does give us an understanding of the way the college-going [population] is socialized.

[Clicker questions] are really helpful because you think about things in a way you’ve never thought about before. You’re like, ‘Oh yeah, there are some inequalities in that’. It helps you put [what you are learning] into real-world situations. When you can put something into an example, it sticks more, and it becomes more relevant too, because it makes you apply it to the class.

In summary, clicker questions can be used to gather anonymous data from students for the purpose of supporting conceptual application, critical thinking, and group discussion.

Discussion

This study is limited by the institutional and cultural contexts in which it was conducted. While useful for pedagogical development, the findings of this study cannot be extrapolated to students attending colleges and universities worldwide. Additional research is needed to explore whether students’ experiences with clickers differ across cultural contexts and disciplinary boundaries. As mentioned, much of the existing research on SRSs examines the effects of clicker use in large science courses. Additional investigation is needed into the implications of SRS use for smaller courses and under various pedagogical approaches. If clickers can indeed be used to make larger classes feel more cohesive, it will be important to discover how this process might differ across disciplines. Furthermore, researchers might explore the effects of learning disabilities, gender, age, and class composition for social cohesion and/or group formation (Goffman 1959) in clicker courses.

Conclusion

To clarify the link between SRS use and existing pedagogical methods, scholars new to clickers need resources containing practical information about how to implement this technology. Clicker use can support what many instructors
are already doing in their classrooms; this article presents data from five courses in three disciplines to show that SRS can be used to support existing pedagogical goals. In the context of five teaching practices, we provide research data and sample clicker questions to illustrate that SRS technologies can be used to facilitate existing pedagogical goals. In fact, unlike the addition of some technologies, which can generate detachment or isolation, when used effectively, clickers increase face-to-face interaction among students. As a result, we believe that when implemented thoughtfully, SRS use can lead to a more cohesive large-class environment. By using anonymous data and encouraging participation (verbal and non-verbal) through clicker use, greater engagement and critical thinking may occur.

As with any teaching technology, it is important that instructors utilize appropriate pedagogical practices with clickers. A well-designed pedagogical strategy, including a sense of one’s learning goals and how to achieve those goals by means of clicker questions, is crucial (Mollborn and Hoekstra 2010). Even when used well, clickers cannot solve all of the challenges that large-class learning environments present. Many students will still feel reluctant to participate in large-group discussions. While the non-verbal participation promoted by clicker use alleviates some feelings of isolation, it is unlikely that clicker use alone will produce levels of participation or social cohesion akin to those more commonly seen in small courses.

Finally, SRS use often results in new problems (e.g., student resistance to increased accountability) and challenges (e.g., how to incorporate clicker use into student grades) for instructors. We believe that increased student participation, conceptual application, and critical thinking are powerful reasons to give these devices a try. By reviewing practices for effective clicker pedagogy and supporting our claims with empirical data, we hope to show that the positive end results can justify the work needed to learn how to use these devices effectively in the classroom.

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Note
1. As defined here, a large course contains 35 or more students, a size at which seminar-style discussions become more difficult.

Notes on contributors
Angel Hoekstra is an instructor and recent graduate from the Department of Sociology at the University of Colorado in Boulder. Her research on the effects of clicker use for learning and interaction has previously been published in Learning, Media, and Technology, and she and Dr Mollborn have also co-authored a publication in Teaching
Sociology. Dr. Hoekstra enjoys teaching Self in Modern Society, Drugs in US Society, Sociological Theory and Sex and Gender. She currently works for the Graduate Teacher Program and she enjoys research designed to improve interactive behavior, student engagement and learning outcomes in higher education.

Stefanie Mollborn is an assistant professor in the Department of Sociology and a faculty member in the Health and Society Program of the Institute of Behavioral Science at the University of Colorado at Boulder. Her research on teenage childbearing and the life course has been published in *Social Psychology Quarterly, the Journal of Marriage and Family*, and the *Journal of Health and Social Behavior*. She teaches social psychology, gender, and health, and she is particularly interested in researching strategies to improve students’ active learning in large classes.

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