Integrating Technology in Today's Undergraduate Classrooms: A Look at Students' Perspectives

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We present the findings of a small-scale study of student opinions drawn from an anonymous and voluntary survey in an undergraduate science classroom. The survey questions focused on the use of basic tools in a college classroom. The tools included in the survey were PowerPoint, overhead projectors/chalkboards, personal response units, and online courses. From our analysis we conclude that students enjoy both the use of traditional and more technologically advanced tools for lecture-style learning when the methods are implemented in manners that are perceived as pedagogically appropriate and effective. We found that students are more dissatisfied with online than in-person classes and that the use of personal response units is viewed as negative and their implementation considered ineffective.

Education professionals of the 21st century have access to radically different technological tools for teaching than those within the field only a decade earlier. The incorporation of technologies into the job force, from policing to the medical field, is widespread and allows professionals of any discipline to conduct their work with increased speed and, to a large extent, accuracy. The integration of technology into the classroom, in both K–12 and secondary education, is no longer simply rising—it is expected by parents, students, educators, administrators, and policy makers (Partnership for 21st Century Learning, 2007; International Society for Technology in Education, 2002). With increased use of technology across all professions, the perception about an individual's skills and expertise hinges on her or his knowledge of technological tools in performing work-related tasks. Technology is meant to clarify concepts, rapidly disseminate information, or simply speed up processes.

Following suit, secondary education institutions have moved to include multiple types of technology into the classroom. Technologies such as PowerPoint are used with regularity, online and hybrid courses are becoming commonplace, and additional devices such as personal response units (PRUs) or "clickers" are being implemented in classrooms nationwide. With this development, educators began discussions about the pros and cons of using technology in the classroom. A great breadth of research has been conducted on both sides of the argument, and giving a complete review is beyond the scope of the present article. We refer the reader to the most cited reviews of literature on these topics offered by Bernard et al. (2004), Mumtaz (2000), and Ringstaff and Kelley (2002). These review articles describe the research on the relation between technology and student learning, explore the kinds of impact technology has on education (Ringstaff & Kelley, 2002), stress the distinction between learning "from" computers and learning "with" computers, and highlight educators' reasons for implementing or resisting new technologies (Mumtaz, 2000). In addition, these reviews provide important data from works that show potential links between pedagogical techniques online and in the classroom and student success rates (Bernard et al., 2004). In the present work, we focus our attention on the perspectives and opinions that students formed or are forming about the use of technology in the classroom.

At the undergraduate level, students have extensive experience with technology and have also been exposed to a multitude of teaching styles, techniques, and technologies. Furthermore, they have become, or are becoming, aware of how they learn best and are critically assessing

their experiences. In this article we present the results of a small-scope survey of undergraduate students, conducted with the aim of contributing to a better understanding of students' attitudes toward certain technological tools in undergraduate education. An important consideration in our study is to assess students' satisfaction. Therefore, we emphasize the analysis of our self-reported data. The selected courses are basic introductory geosciences courses that are popularly taken to satisfy a general education requirement at an urban college that is part of a larger university system. The students are from varying socioeconomic and educational backgrounds, from all collegiate academic levels, and potentially from all majors, science and nonscience; thus this population has the potential of offering opinions from different disciplinary and experiential perspectives within the college environment.

Following this introduction, the contextual background section briefly summarizes 20th- and 21st-century history of educational technology as related to our research interests. We then describe our approach and the setup of the survey. The assessment and interpretations of the survey's responses are detailed, followed by a brief discussion of our findings and a summary and conclusion.

Background and research question

The implementation of technology in classrooms dates from the Industrial Revolution. In 1870 the Magic Lantern, a primitive version of a slide projector that projected images printed on glass plates, began circulating through the Chicago public school system (Akanegbu, 2013). The chalkboard came around in 1890, followed by the pencil in 1900, and in 1930 the overhead projector arrived. The 1950s brought about the advent of videotape technology, an exciting method of learning for students. The 1970s brought the photocopier, the handheld calculator, and the Scantron, each allowing for the rapid mass production of materials, calculations, testing, and grading. Each of these technologies is now standard. Personal computers were already available and common in the 1980s, but their costs and restrictions on commercial use did not allow for the rapid integration of this technology until well into the 1990s. The National Center for Education Statistics reports that by 2009, 97% of classrooms had one or more computers, and 93% of classroom computers had internet access (Gray, Thomas, & Lewis, 2010). Instructors stated that 40% of students used computers often in their educational methods, in addition to interactive whiteboards and digital cameras (Gray et al., 2010).

The number of students in classrooms has also increased. The U.S. Department of Education reports that high school enrollment was only 10% in 1900, but by 1992 had expanded to 95%. The number of students in college in 1930 was around 1 million, but by 2012 had grown to a record 21.6 million (Snyder & Dillow, 2013). Educators needed new methods of instruction and testing to handle such vast numbers of students on time, and students growing up in a digital era were looking for new ways to communicate, study, and learn. Access to computers and their corresponding technologies (e.g., popular software programs, the internet) have consequently allowed these tools to enter the 21st-century classroom to further the efficiency and effectiveness of education. Yet, chalkboards, overhead projectors, and similar noncomputer-based tools remain in use in today's classrooms.

Lectures have been the most common form of teaching and learning since ancient times. Discussion methods in small groups are also favored by many and appear to be very effective in attaining higher level intellectual learning (Cannon, 1988; Huba & Freed, 2000). The increase in the number of students attending college has been far superior to the necessary increase in teaching staff to allow for smaller classes; therefore, it may be unavoidable that undergraduate students will continue to receive a large amount of their instruction in the form of the traditional lectures in the future (Seth, Upadhyaya, Ahmad, & Moghe, 2010), particularly at large public institutions, presently and in the foreseeable future. The need to serve a larger student population with limited human resources may have hastened the implementation of technologies in the classroom. Yet research has suggested that educators have not achieved high levels of effective technology use in the classroom in the United States and internationally (Bauer & Kenton, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Kozma, 2003; Mueller, Wood, Willoughby, Ross, & Specht, 2008; Smeets, 2005; Tondeur, van Braak, & Valcke, 2007). Further, the integration and utilization of technology in classrooms typically does not support the kind of instruction believed to be most powerful for facilitating student learning—the student-centered approach (Cuban, Kirkpatrick, & Peck, 2001; Ertmer & Ottenbreit-Leftwich, 2010; International Society for Technology in Education, 2002; Partnership for 21st Century Learning, 2007). It is possible that the available technologies to be integrated have not yet evolved or are available to allow for a focus on the student-centered approach in certain types of institutions.

An important consideration in discussing and assessing academic education is students' satisfaction. Student satisfaction is often defined as the student's perception of the college experience and perceived value of the education received while

attending an institution (Astin, 1993). Satisfaction has also been found to be a high predictor of retention (Astin, 1993; Edwards & Water, 1982) and an important factor in academic success (American Psychological Association, 1995). Student satisfaction has been found to be an important factor in determining the level of student motivation in a course (Chute, Thompson, & Hancock, 1999; Donohue & Wong, 1997). Further, instructors and instructor performance have been found to play a key role in determining student satisfaction (Finaly-Neumann, 1994; Williams & Ceci, 1997). Considering that instructor performance, which includes the use of technological tools, contributes greatly to student satisfaction and that lecture-dominated teaching will not soon fade, it is important that lectures and the delivery of material be as effective as possible in accomplishing the course objectives and learning outcomes (Garrison & Kanuka, 2004; Kirkwood & Price, 2005; Walton, 1972).

Although teaching styles vary among educators, the use of teaching tools has increased dramatically since the rapid integration of computer technology in the public sector. Some educators prefer PowerPoint, others only use the traditional modes of chalk or similar handheld writing utensils; overhead projectors are still found in most lecture halls, whereas online platforms have gained ground in their implementation. In the present work we focus on a small-scope survey of students' perspectives on the success and/or failure of the technologies in the classroom. The survey was geared to uncover which tool the students feel that they learn best from and which tool accomplishes its stated purpose, and also to explore the reasons for students' preferences. We also sought to determine whether specific teaching tools being used were deemed by students to be beneficial to their learning and advancement. When put in the proper context, the comments solicited from the students, which reflected their level of satisfaction with a classroom setting, may be used as an additional measure of the success of educators in engaging students and facilitating meaningful learning experiences.

Setup and methodology

Exemption was given from the human subjects review board as the survey inquired about existing technology in the classroom. Students were given an oral informed consent and were told that participation was voluntary, no identifying data would be collected, no benefit or penalty would be incurred by participating or not, and participation in the survey served as a consent form. This procedure was approved by the board. Although the survey was conducted while students were enrolled in two specific courses, students were directed to answer the survey questions with regard to all their course experiences.

Two introductory courses in basic physical science, specifically Earth science, were selected to conduct the survey: GEOL 100 (Introduction to Geology) and PGEOG 130 (Weather and Climate). The selection of the courses was based on their popularity as introductory science courses satisfying institutional general education requirements, diversity of enrolled students, and feasibility of conducting the study with a minimum of interruption for the classes. The latter was related to the courses being taught in the authors' academic department and disciplines. Both courses satisfy institutional Common Core requirement (CCR) in the areas of Scientific World and Life and Physical Sciences, respectively; do not specify prerequisites for enrollment; and are mostly taken by students that do not plan to major in the fields of Earth science. CCR is a set of courses that the college considers essential to the intellectual development of its undergraduates, preparing them for advanced study; sharpening their essential academic skills in writing, mathematics, scientific reasoning, and critical thinking; and enabling them to become active participants in the world of ideas through exposure to various academic disciplines. CCR is often referred to as general education requirements at other American institutions. The student population is diverse in terms of students' previous years at the institution, with some in their freshman year but many in their junior and even senior year needing to satisfy the core college science requirement after they have nearly completed their study programs. Students from these courses voluntarily participated in the anonymous survey, which consisted of simple yes/no questions followed by a space in which they were asked to comment on the reason or reasons for their answers to the survey questions. Our survey did not collect specific information about class demographic, such as major (if any), gender, or undergraduate level.

At the time we conducted our survey (fall semester 2014), 155 students and 208 students were officially enrolled in GEOL 100 and PGEOG 130, respectively. The numbers are typical for the enrollment in these classes, which are held in large lecture halls. Lecture attendance is not mandatory, although it is strongly recommended and does affect the final grades, and on average about 40% of students attend lectures regularly. This percentage of attendance is typical for courses that satisfy the CCR at our large urban institution (over 20,000 students), characterized by a commuter student population with many full-time students holding outside part-time jobs and with more than one third of students working full time while also pursuing a degree. The setup of these classes does not offer a structure to allow for regular

student-centered learning.

Two different instructors taught the two courses considered in this study with different lecturing styles in terms of the use of visual material as aids in the classroom. The instructor for GEOL 100 used mostly an overhead projector, writing the main points about each topic by hand as she explained them, and integrated some video components into the classroom when pertinent to the topic. The instructor of PGEOG 130 used mostly PowerPoint-prepared lectures and integrated videos of weather phenomena in her presentations. The latter instructor occasionally used the overhead projection. All PowerPoint and videos were made available to the students prior to the lectures that they covered, students were able to print out or download the lecture at their discretion, and the slides remained available until the end of the term. Neither instructor used PRUs in their classes.

The survey questions and a summary of responses are listed in Table 1. The total number of responses is consistent with the rate of attendance to these classes, as discussed previously, as we note that only a very few students selected not to participate and left the room earlier. All percentages are computed with respect to the number of responses. We have included under "no response" all survey answers that did not include a circle or cross for the letters Y and N, answers that selected both, and answers that were too ambiguous. The design of the survey allowed for comments to accompany all the questions, and these comments were helpful in providing further insights into students' perceptions and opinions about the dynamic in classrooms.

Assessment and interpretation of responses

Some general patterns emerge from the statistics in Table 1 and from the comments on the surveys, which the large majority of respondents provided. Comments from respondents of both courses were consistent in their similarity; therefore, our discussion of comments does not distinguish between these two populations unless specifically stated. A large majority of students in both courses had not taken online courses by the time of this survey (Question 1) and clearly favor those aspects of technology in the class-

TABLE 1

Survey questions and summary of responses.

Questions	GEOL 100	PGEOG 130
1. Have you ever taken an online course?		
Y (yes)	22.5%	19%
N (no)	77.5%	81%
No response	0	0
2. Do you like online courses?		
Y (yes)	18.3%	21.4%
N (no)	64.8%	58.4%
No response	16.9%	20.2%
3. Do you like "clickers" (personal response units) in classes?		
Y (yes)	21.1%	26.2%
N (no)	67.6%	54.4%
No response	11.3%	21.4%
4. Do you like the use of PowerPoint presentations in the classroom?		
Y (yes)	80.3%	86.9%
N (no)	19.7%	10.7%
No response	0	2.4%
5. Have you ever skipped class because you knew you could access the PowerPoint notes via Blackboard or another platform for notes?		
Y (yes)	40.8%	28.6%
N (no)	59.2%	71.4%
No response	0	0
6. Do you like the use of overhead projectors, white boards, or other "antiquated" tools in the classroom?		
Y (yes)	88.7%	83.3%
N (no)	7.1%	11.9%
No response	4.2%	4.8%

Note: Total number of responses in GEOL 100 class = 71 (45.8% of total enrollment); total number of responses in PGEOG 130 class = 84 (40.4% of total enrollment).

room that enhance the clarity of a lecture (PowerPoint) and the additional explanations that the instructor provides when writing on whiteboards or overhead projectors (Questions 4 and 6, respectively). The favorable responses to Questions 4 and 6 shown in the table indicate a larger percentage of satisfaction with PowerPoint lectures in the course PGEO 130 and a larger percentage of satisfaction with "antiquated" tools in the course GEOL 100, respectively. It may be argued that using the somewhat negative term *antiquated* influenced students' responses. However, the differences between the data indicate that this is not the case (~5–6%) and that the students may have been influenced by the different teaching styles of the instructors of these courses in that particular semester, which we described earlier. Comments provided for Questions 1 and 2 will be discussed separately because they are more nuanced and interdependent.

In their comments concerning Question 4, respondents stressed the visual (graphs, charts, tables, etc.) importance of PowerPoint in aiding their learning process. The reasons for their satisfaction with PowerPoint-based lectures are related to their organization and summaries of class material, accessibility beyond the classroom, value for reference and reviews, and usefulness in aiding note taking. The small percentage of students reporting dissatisfaction with PowerPoint-based lectures expressed concerns with the style of delivery rather than with this aspect of technology being used in the classroom. The comments consistently referred to "too much information" on slides and losing focus as a result of that, professors reading what is on the screen, and the fast speed with which professors go over the lectures as detrimental to their attention in class. Question 6 returned favorable comments similar in emphasis to those for Question 4 in relation to helping students stay focused and aiding with their own note taking. The comments stressed their preference for the more interactive and generally slower pace of the lesson's delivery accomplished with the overhead projector. Dissatisfaction resulted from the "professor's poor handwriting" and lack of accessibility beyond class.

The admission of skipping class because of easy accessibility of PowerPoint lecture notes away from the classroom (Question 5) was qualified by a large majority of respondents with an "only in emergency/extreme cases" comment, whereas many noted "convenience" as a reason. Some comments reflected negative experiences with instructors, expressing that "lecture is identical to the slides" and "I can read the slides to myself." The most common responses for those who never skipped class were: "I learn more in class" and "I never skip class." The difference in the percentages for Question 5 between the two courses is quite large (~12%). Research has shown a direct correlation of unconscious preferences for items and styles that are more familiar to individuals (Maio & Haddock, 2009). Familiarity due to what is known as mere-exposure effects directly influences people's preferences (Hansen & Wänke, 2009). In our context, although the survey was not directly aimed at the courses in which the survey was taken, it is possible that the differences reported were related to the two different teaching approaches used by the instructors during the semester; PowerPoint was mostly used in PGEOG 130 but hardly ever used in GEOL 100.

Our institution does not require the use of student response systems across the board, and consequently it does not provide PRUs to students. Hence, courses that choose to use these units or clickers also require students to purchase them. At the time of writing, the institution had not collected data on the number of classes (or students) that had participated in classes using clickers, but our own (informal) search of web pages for introductory courses turned up only a handful of courses that in the past few years experimented and/or adopted the regular use of clickers. Table 1 shows that Question 3 has the widest spread of percentages. Although a marginal majority returned an answer of "No" when asked about liking clickers, we note that many of those answers were qualified with a "never used them" comment. In addition, respondents consistently wrote that "they are too expensive" and that students "shouldn't have to pay for the professor to take attendance and such." Those who did prefer the use of PRUs largely stressed their convenience and that "when used correctly they are great in a large group." Few students found clickers useful in helping them participate in large classes, as opposed to simply raising their hand, which according to one comment "doesn't always work."

In the last part of this section, we focus our attention to Questions 1 and 2 of Table 1. As mentioned previously, the majority of students had not taken an online course when surveyed. From the comments, two distinct types of reasons were established: one type had to do with the institutional setting and the other type was related to a personal choice. There is a notable lack of availability of online courses at the institution of this study, thus the statement "no opportunity to take an online course" was mentioned with high frequency. The comments that belong to the second category of reasons were mostly cast in terms of preference for learning more effectively "with human interaction," lack of "appeal" of online courses, and online classes as

detrimental to their motivation to study ("I am lazy") or managing their time effectively. Similarly, those respondents who had taken online courses mentioned institutional-based reasons, such as "a specific course was only offered online," and reasons that were related to personal choices or particular personal needs, such as scheduling issues and preference for working "at home/café/park." The reasons given in surveys returned with "no response" were either that there had been no opportunity to enroll in online courses or that the respondent did not have knowledge or information about these courses.

TABLE 2

Summary for Question 1 (Have you ever taken an online course?) and Question 2 (Do you like online courses?) related to enrollment and satisfaction with online courses in percentages (no. of respondents in parentheses).

	GEOL 100		PGEOG 130	
	Had enrolled in online class	**Had not** enrolled in online class	**Had** enrolled in online class	**Had not** enrolled in online class
Did like	43.75% (7)	11% (6)	56.25% (9)	18.37% (9)
Did not like	56.25% (9)	67.3% (37)	18.75% (3)	81.63% (40)
No definite opinion	0	21.8% (12)	25% (4)	0
Total	16 respondents	55 respondents	16 respondents	49 respondents

Note: GEOL 100: Introduction to Geology; PGEOG 130: Weather and Climate.

Responses for Question 2 analyzed in conjunction with the percentages in Question 1 are summarized in Table 2. The percentages shown in the table were calculated with respect to the total number of respondents that selected "Y" and "N" shown in the last row of the table; therefore, these statistics exclude those respondents classified as "no response" in Table 1. Table 2 therefore shows the total number of students from both courses participating in the survey that answered Questions 1 and 2. This population was separated into two groups: students who had taken an online class and those who had not. In both cases, responses were then classified into "did like," "did not like," and "no definite opinion." The latter classification includes those answers that specified being neutral toward online courses, those that specified not having formed an opinion for other reasons, and those answers that were ambiguous (e.g., with more than one option circled). As expected, students who had taken courses online and were satisfied with that option listed reasons consistent with personal choices: scheduling convenience, control of one's own time, saving of commuting time, and the possibility of studying anywhere rather than in the confines of the institution. These were also the reasons given by students who had not yet taken an online course but indicated their liking of such courses.

Despite differences shown in Table 2 between percentages from the different classes with respect to participating, and liking/disliking online course, overall the majority of respondents expressed dissatisfaction with this approach to education. A total of 136 surveys were considered in computing the percentages in the table, 89 of which returned with negative answers to the question of "Do you like online courses?" which constitutes a 65.4% dissatisfaction rate. In listing surveys under the latter category ("did not like"), close attention was paid to the comments added to a choice to assess whether respondents selected the negative answer simply because of a lack of informed opinion about these courses or because they had a well-developed opinion and ideas about such courses. We found that most students had formed their own ideas about this use of technology, either after their own personal experience (many students had participated in hybrid-type courses) or that of their peers. The reasons most frequently reported for not liking online courses were all of the personal type. Students commented that online courses are "not engaging" enough and that the lack of direct contact with the professor was detrimental to their learning and progress through new material ("I learn more in face-to-face classes"). Loss of focus and motivation were also frequently mentioned, and students stressed their preference for the possibility of interactions that can happen in a classroom, not just with professors but with other students. Several students commented on this educational tool as a "technological hassle and a nuisance." Finally, a sentiment that emerged from reviewing the comments can be summarized by the following quote "I shouldn't have to pay to teach myself," referring to tuition fees due to the institution.

Discussion

Online courses

Researchers have found that there are areas that are important for student satisfaction with online in-

struction. Students have cited that the interaction among students, the quality and timely interaction between student and professor, a consistent course design across courses, technical support availability, and flexibility of online courses are integral to student satisfaction in online learning (Aggarwal, 2000; Astin, 1993; Belanger & Jordan, 2000; Bolliger, 2004; Bower & Kamata, 2000; Mood, 1995; Moore & Kearsley, 1996; Young & Norgard, 2006). Though the points addressed previously were not the center of this investigation, the majority of students who have taken online courses have stressed that their discontent stems from feeling that they learn better in a more traditional setting or that the online instruction is not guiding them in learning any differently than self-study alone. Further, this investigation does not delve into the intricacies of online pedagogy, but one may infer that outside of the number of courses offered, student dissatisfaction is due to the potential lack of interaction among students (synchronous or asynchronous discussions), quality and timely interaction between student and professor, inconsistent course design across courses, or reduced technical support. This may be suggesting the need for formal training for online course teaching or a standardization of online course implementation campuswide.

"Chalk and talk" versus PowerPoint

PowerPoint-based lectures are increasingly being delivered in colleges and universities worldwide and their value in learning has been questioned in all disciplines (James, Burke, & Hutchins, 2006). Educators are divided when considering the superiority of PowerPoint with respect to the traditional "chalk and talk" method (Amare, 2006). Similar divides have been found in studies of students' preference to these varying technologies. Research was conducted in India on medical and dental undergraduate students' perceptions of three lecture delivery methods: PowerPoint, overhead projector, and chalkboard (Seth et al., 2010). The majority of medical students (65.33%) preferred PowerPoint presentations, whereas 15.16% preferred the lectures using chalkboard, and 19.51% preferred the overhead projector for teaching ($P < .001$). Of the dental students, 41.84% preferred chalkboard, 31.21% preferred overhead projector, and 25.85% preferred PowerPoint presentations in the lectures ($P < .05$).

Seth et al. (2010) determined that the medical students clearly preferred the use of PowerPoint presentations, whereas the dental students did not. However, the study does not bring out evidence-based superiority of any lecture delivery method. In our investigation of the introductory Earth science courses, the student comments addressed favorable and unfavorable aspects of each tool beyond their personal preferences. Some notable comments include:

> "They (PowerPoint presentations) should be posted online to make studying easier but their overuse in the classrooms has made teachers lazy and uncreative."

> "Most of the times they (PowerPoint lectures) contain too much information and are transitioned through way too fast, whereas if the professor is writing/drawing information out there is time to copy—not to mention better visuals than words on the screen."

> "They ('antiquated' tools) are good tools to use when you need to explain more concepts with images or equations. It is also nice to be able to write down your notes in the same way the professor would. It helps you understand concepts better. It is easier to learn and remember more with visual notes."

Clark (2008) found that when used by a trained teacher, any teaching aid would be appropriate and effective in delivering the content in a lecture. With this perspective in mind, we interpret these comments to indicate dissatisfaction with the ineffectual use of a tool rather than a statement on the intrinsic value of the tool itself.

Access to lecture material

Student absenteeism results in inadequate learning and poorer academic performance (Gump, 2005; Marburger, 2001). Students readily admitted to cutting class when the lecture material was made available online. However, there was often secondary reasoning given for justification. The most common reasons centered on poor implementation of the PowerPoint tool (e.g., "I can read the slide to myself"; "It's easier to teach myself"). Alternately, students stated that having the lecture material available assisted in their learning course material when absent or distracted in class. Students lauded the opportunity to print out PowerPoint slides prior to lecture to assist in note taking. There is no evidence that making lecture materials available to students has a negative impact based on the data and comments in this investigation.

Personal response units

PRUs can be used in classrooms to rapidly assess students' progress in comprehension of course content. The data collected by the PRU software during an in-class question-and-answer dialog could then be matched against the names of students enrolled in the course. Thus, the units would allow for an easy

record of attendance on the part of the instructor. Further analysis of survey Question 3 about PRUs showed that cost of the units is a large cause for discontent. Of the 48 respondents in GEOL 100 who did not like PRUs, 14 (29%) expressed cost as an issue, 5 (10%) stated that there were technical issues, and 10 (21%) referred to other issues such as the devices being inconvenient, impersonal, cumbersome, and unnecessary. Of the 44 respondents in PGEOG 130 who did not like PRUs, 14 (32%) expressed cost as an issue, 4 (9%) stated that there were technical issues, and 13 (29.5%) referred to other issues such as the devices being inconvenient, impersonal, cumbersome, and unnecessary.

Clickers are not always cheap or even well made, and many schools put the burden of cost and care on the student. Few colleges and universities have a unified system of devices, thus students may be required to purchase multiple units because of professor preference of brands and software systems. Students surveyed in the present investigation are part of a university system that does not require a single unit system. The cost of clickers is directly stated as the primary cause for the starkly negative tone of students' perception of the devices. Less frequently, comments point to poor implementation or the misuse of the clickers' purpose on behalf of individual instructors.

Conclusion

In this study we have presented the results of a small-scale survey of opinions about the use of some basic technological tools in a large, lecture-style class setting, specifically using students in introductory courses in Earth science. The basic technological tools included in the survey were PowerPoint, overhead projectors, whiteboards and chalkboards, PRUs, and online courses. From our analysis, we conclude that students clearly enjoy the use of traditional and more technologically advanced tools for lecture-style learning when the tool is implemented in what is perceived as an appropriate or sound pedagogical manner. In addition, we found that students are commonly more dissatisfied with online courses than in-person classes and that the use of personal response units or clickers is overwhelmingly viewed as negative and their implementation is considered ineffective. As a result of these findings we feel confident in recommending more focus on pedagogical support and training of teaching staff, particularly in disciplines that traditionally do not require pedagogical coursework at the doctoral level. A more sustained effort by academic institutions toward student-centered learning is needed, particularly including large components of student activities in all classrooms regularly. In summary, it is the pedagogical technique and skill of the educator in the use of the technological tool that determines positive or negative perception of its success, rather than the tool itself. ■

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