

Exploring Undergraduates' Perceptions of the Use of Active Learning Techniques in Science Lectures

By Ashley J. Welsh

This paper examines students' mixed perceptions of the use of active learning techniques in undergraduate science lectures. Written comments from over 250 students offered an in-depth view of why students perceive these techniques as helping or hindering their learning and experience. Fourth- and fifth-year students were more likely to view in-class active learning techniques as a waste of lecture time, whereas third-year students and females perceived these techniques as instrumental to improving their understanding and their interactions with professors and peers. Students also provided recommendations for the effective use of active learning techniques in lecture.

Broadly defined, *active learning* is the instructional approaches or methods that “engage students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they’re doing” (Prince, 2004, p. 223). Research shows that the use of active learning techniques has a positive impact on student learning and enjoyment in undergraduate lectures (Ernst & Colthorpe, 2007; Hake, 1998; Trees & Jackson, 2007). Handelsman, Miller, and Pfund (2007, pp. 47–64) encouraged assessment methods that both engage students in their learning and allow them to gauge their learning in a course. Active learning techniques such as peer instruction, electronic classroom response systems (i.e., clickers), and interactive demonstrations have been linked to improved conceptual and problem-solving skills in science courses (Crouch & Mazur, 2001; Hake, 1998; Prather, Rudolph, Brissenden, & Schlingman, 2009). The facilitation of clickers helps to break up the monotony of traditional lecture, enables large classrooms to “feel small,” and provides more direct feedback to students (Trees & Jackson, 2007). Often paired with clicker questions, small group discussions allow students to interact with each other

and yield a means for students to dispel particular misconceptions by discussing concepts and reasoning with each other (Crouch & Mazur, 2001; Machemer & Crawford, 2007; Meyers & Jones, 1993; Smith et al., 2009). The incorporation of such engagement techniques in lecture is useful in encouraging students to be more invested in their own learning in ways that could improve their performance in science courses.

If the use of active learning techniques is to be adopted more widely within undergraduate science courses, there is a need to explore and document students' perceptions of active learning techniques. Although students typically enjoy the use of active learning techniques, many still perceive traditional methods of teaching as more beneficial to their learning (Covill, 2011; Fox-Cardamone & Rue, 2003). In their study examining small-group and whole-class discussions, Fox-Cardamone and Rue (2003) found that although roughly 70% of students enjoyed the use of small-group discussion in lecture, almost 80% of students would have preferred more traditional, lecture-style teaching. Students' perceptions and acceptance of in-class active learning strategies can be influenced by classroom norms and classroom interactions among instructors and the students (Turpen

& Finkelstein, 2010). In addition, students are not only participants within the classroom, but can also provide insight as to how to improve the facilitation of such techniques. For instance, Perkins and Turpen's (2009) exploration of students' perspectives of the use of clickers in upper-year physics courses presented students' thoughtful and relevant recommendations as to how instructors might use clickers effectively in lectures.

The majority of research assessing students' perceptions of active learning techniques has used surveys or questionnaires as a data collection method. It is rare that studies allow students the opportunity to describe, in their own words, their opinions regarding the use of active learning techniques in lecture. In their survey reviewing the use of clickers in large lectures, Trees and Jackson (2007) indicated that although students were encouraged to comment on their experience with clickers, few actually did. This is not the case, however, for the study described in this paper, in which over 50% of the respondents to a survey wrote comments on in-class active learning techniques.

This paper reviews the written comments from 260 undergraduates pursuing science degrees. In a survey exploring the factors influencing students' academic performance in math and science, students were asked to rate the importance of the use of in-class active learning techniques and to comment on their experience with these techniques. A coding scheme was developed to analyze students' comments and to identify common themes. The comments varied from positive to negative evaluations, with most students providing suggestions as to how active learning techniques should be used in lecture.

Methods

Research context

The open-ended comments about the use of in-class active learning techniques were part of a larger study exploring the factors that undergraduates within the Faculty of Science at the University of British Columbia (UBC) perceived as influential to their academic performance. Administrators within the Faculty of Science at UBC were interested in research that provided an overview of students' experiences, perceptions, and concerns both inside and outside of the Faculty. As a result, a mixed-method study was conducted with data being collected via a self-developed survey (492 respondents), 24 one-on-one interviews, and a four-person focus group discussion. Twenty professors teaching second-, third-, and fourth-year undergraduate science courses in the winter 2010 school semester forwarded an e-mail from the primary researcher to their students. The e-mail described the objectives of the study, provided a link to the online survey, and encouraged students to sign up for one-on-one interviews and a focus group discussion. The completion of the survey was voluntary and had no association with students' course grades.

The data for this paper include students' responses to a pair of questions from the survey. One question asked students to rate the importance of the use of in-class active learning techniques and the other was a follow-up question asking students to comment on their response as to why they perceived these techniques as important or unimportant.

Participants

The participants in this study were undergraduates pursuing a biological, physical, and/or mathematical sciences degree within the Faculty

of Science at UBC. Students in second year or higher were targeted for this research under the assumption that they have had more experience in the Faculty of Science in comparison to their first-year peers. Although there was representation from students from all departments, the survey sample was favored to women ($N = 287$, 58%), biology majors ($N = 163$, 33%), third-year students ($N = 181$, 37%), and students of White ($N = 189$, 38%) and Chinese ($N = 170$, 35%) race/ethnicity. Four hundred and ninety-two students from the Faculty of Science completed the survey and 260 of those students commented on the use of in-class active learning techniques. The response rate for the survey was 19% ($n = 492$).

Collecting student perceptions of in-class active learning techniques

To gather content for the student survey, meetings were held with faculty, administration, and students within the Faculty of Science at the UBC to discuss the factors they perceived as influential to students' academic performance in science. Throughout these discussions, the topic of active learning techniques and their use in lecture came up frequently. As a result, a close-ended question on a 5-point Likert scale was included within the survey, asking students to "Rate how important in-class active learning techniques were to influencing [their] academic performance in math and science courses." During the survey validation process, students related in-class active learning techniques with tools or activities such as clickers and/or group discussions that engaged them in class and provided feedback. When discussing in-class active learning techniques, students' responses were varied. Some students

thoroughly enjoyed the use of in-class active learning techniques, whereas others had strong, negative opinions of their use. Following much discussion with students and colleagues on how to address these alternate views, an open-ended question was included directly after the close-ended question. It asked students to “use the following space if [they had] any comments on the use of in-class active learning techniques.” This open-ended question allowed for a more authentic representation of students’ perceptions than the close-ended question alone.

Data analysis

The responses to the close-ended survey question were analyzed using an independent *t*-test and an analysis of variance (ANOVA) to detect significant differences between students’ responses on the basis of their gender and year of study, respectively. Furthermore, an independent *t*-test was used to determine if there was a significant difference between the close-ended responses of students who did and did not write comments. The 260 open-ended comments were read and reread several times in order to develop a coding scheme based on the content of the comments. The comments were first categorized on whether they addressed active learning techniques in general or more specific techniques such as clickers or group discussion. These categories of comments were then assessed as to whether students held positive, negative, or conditional views about their use, and emergent themes were extracted (i.e., Waste of Time, Improves Understanding, and Instructor Use). The comments were considered conditional if the students wrote that the effectiveness of active learning techniques was dependent on another factor, such as how the

instructor used them or whether the students in the class genuinely participated. The comments were coded independently by a fellow researcher and myself and then compared. The interrater reliability for the comments about in-class active learning techniques was roughly 95% (15 of the 260 comments lacked coding agreement). Discrepancies among the coding were discussed and resolved.

Results

Detecting for statistically significant differences

As expected, overall student responses to the close-ended survey question were mixed (Figure 1). Roughly 30% of 492 survey respondents perceived in-class active learning techniques as unimportant or slightly important to positively influencing their academic performance, another 30% perceived them as somewhat important, and about 40% perceived them as important or very important.

When analyzing the responses to this question on the basis of students’ demographics (gender, year of study, ethnicity, achievement), significant differences were identified for gender and year of study. An independent *t*-test revealed a significant difference between male ($M = 1.86$, $SD = 1.28$) and female ($M = 2.19$, $SD = 1.10$) student responses, with females placing more importance on the use of in-class active learning techniques ($t = -3.240$, $p = .001$) as positively influencing their academic performance. According to a one-way ANOVA analysis, students’ perceptions were also influenced by their year of study, $F(2, 252) = 7.17$, $p = .001$ (Figure 2). Contrasts revealed no effect between second-year ($M = 2.18$, $SD = 1.16$) and third-year ($M = 2.16$, $SD = 1.12$) students; however, there was a significant effect between

students in second and third year and those in fourth year and above ($M = 1.77$, $SD = 1.24$). Students in fourth year and above perceived the use of active learning techniques in lecture as less important to positively influencing their academic performance in science than students in second and third year.

A plot of the mean responses of males and females in second, third, and fourth year of study revealed that although females placed more importance on the use of in-class active learning techniques than males, the importance placed by males and females of different years of study followed a similar trend (Figure 2). Overall, females and students in second and third year perceive in-class active learning techniques as more important to positively influencing their academic performance in lecture.

An independent *t*-test revealed that the close-ended responses of students who wrote comments ($M = 1.98$, $SD = 1.30$) did not differ from those of students who did not leave a comment ($M = 2.10$, $SD = 1.09$); $t = 1.16$, $p = .25$. Both groups of students held mixed views as to whether in-class active learning techniques positively influenced their academic performance in science courses.

Open-ended comments

As noted previously, students held mixed views as to whether the use of in-class active learning techniques was important to positively influencing their academic performance. The analysis of students’ comments revealed more explicitly why they held these different views. Some students commented more generally about active learning techniques, whereas others were specific to particular tools and/or techniques including

clickers and group discussion. On the basis of this division, students' comments were categorized as *general, about clickers, and about group discussion*. Within these categories, the comments were attributed as being positive, negative, or conditional (Figure 3). As is evident in Figure 3, the majority of the comments referred to the use of clickers within the classroom ($N = 170, 58\%$).

The content of the negative, positive, and conditional comments are summarized in Table 1 and will be described more thoroughly in the subsequent sections.

Negative comments

The most common negative comments concerning the use of in-class active learning techniques was that they were a waste of class time, and with respect to clickers, they were a waste of students' money. Almost half of the negative comments about clickers were contributed by fourth- and fifth-year students ($N = 31, 49\%$). This group of students was more inclined to comment on how clickers were a waste of their money, which might have stemmed from the fact that during their time as students at UBC, they were required to buy two different clicker devices, as illustrated below:

The University of British Columbia keeps changing its technology every year. It just is not feasible to students having to buy new expensive clickers each year. I would rather not have it in my classes because of this reason.

A few of the negative comments indicated that clickers were typically used for attendance purposes and that most students just copied one another's responses instead of trying

FIGURE 1

Students' responses to how important in-class active learning techniques are to positively influencing their academic performance in science.

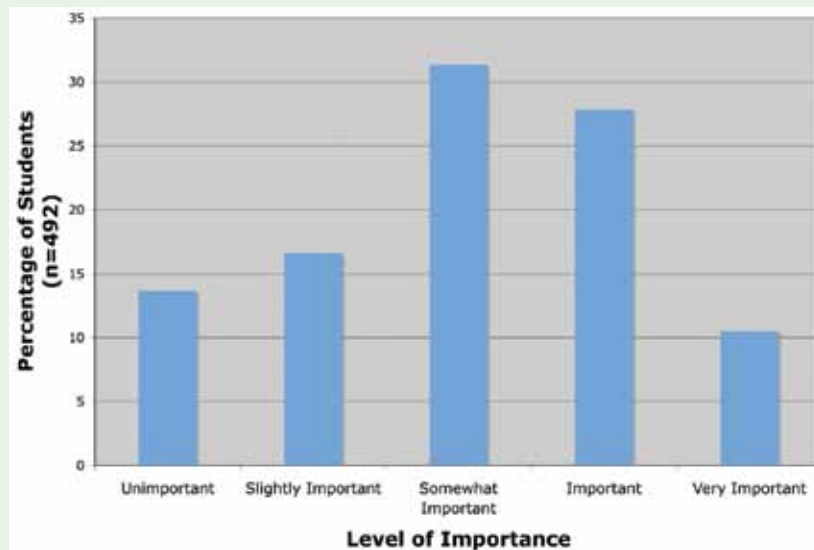


FIGURE 2

Male and female survey responses (by year of study) to how important in-class active learning techniques are to positively influencing their academic performance. Although females placed significantly more importance on the use of active learning techniques in lecture, when accounting for the year of study, males' and females' responses follow a similar trend.

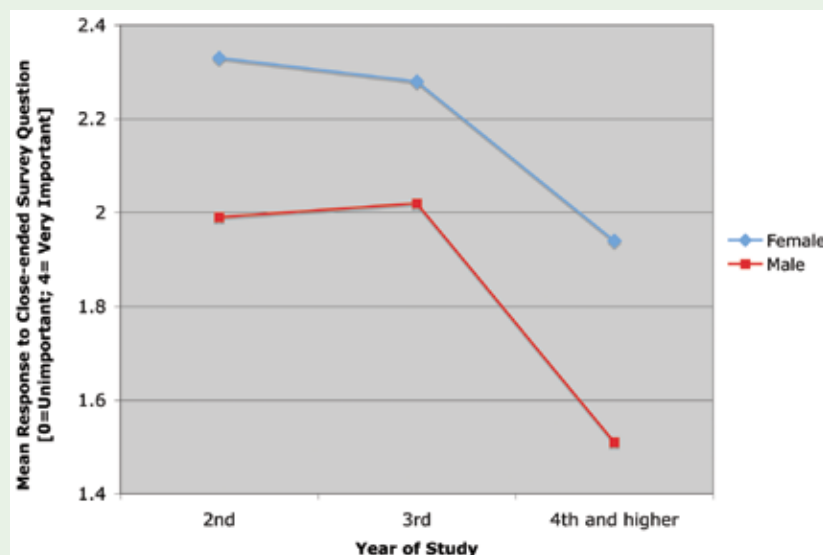
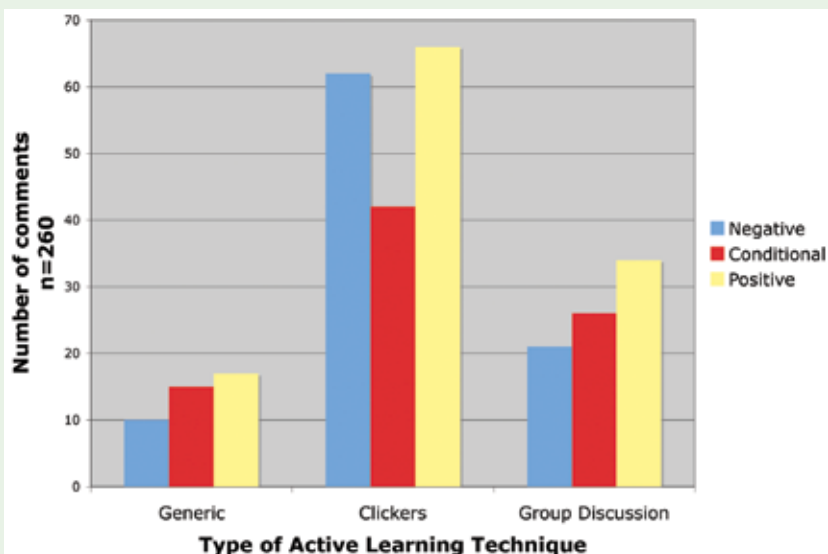


FIGURE 3

Number of students who wrote negative, positive, or conditional comments regarding the use of active learning techniques in general or, more specifically, about the use of clickers and group discussion in class.



to learn from their use. With respect to their learning in science courses, six students expressed their preference for traditional ways of teaching because “clickers were not helping [their] learning” or were “pointless for learning.”

For in-class group discussions, females wrote more negative comments ($N = 27$, 82%) about their use in class than their male peers ($N = 6$, 18%). Eighteen students commented that in-class group discussions were a waste of lecture time because students would get off track or did not want to participate. One student commented as follows:

I find these approaches a waste of class time, especially group activities as most times science classes are too large to ensure everyone is productive, and most times people discuss other things, such as social events.

Positive comments

Students’ positive comments addressed the benefits of using active learning techniques in lecture. The majority of positive comments were from third-year students, especially when discussing the use of clickers ($N = 35$, 56%; Figure 3). Students expressed that clickers were a great way to stay engaged in class and to receive feedback regarding their understanding of the course material. One student commented, “I find that the use of in-class learning techniques helps to keep me interested in the material. Engaging with my classmates and the teacher reinforces the material and helps me understand it.”

Students also commented that clickers and group discussion helped to reveal their misunderstandings and allowed them to see that they are

not the only ones who “don’t get it.” Following is one student comment:

Clickers are really great things. I’ve been relieved when, for example, 75% of the class selected my incorrect answer. It forced the professor to go over that material in a very beneficial way. I feel that if he simply asked “everyone understand?” no one would have said anything and we would have moved on.

When considering students’ year of study, just over half of the positive comments about in-class group discussions came from students in fourth year and above. Although females were more likely than males to write negative comments about group discussion, 12 females wrote positive comments. One female commented, “I like when the instructor promotes group discussion. You get to meet people in class as well as hear different views on the topic being taught.”

Students indicated that they enjoyed having the opportunity to discuss the course content with their peers as it helped them to build a sense of community within the classroom and to hear different points of view on a particular topic.

Conditional comments

The conditional comments were more thorough than the positive or negative comments. Students indicated they understood how active learning techniques could be used effectively in lecture and offered suggestions or examples of how to accomplish this. For the conditional comments, 22 students expressed that the way the instructor used the technique was instrumental as to whether the tool promoted student learning and under-

standing. One student made the following comment:

I think that the use of these types of pedagogical approaches “just for the sake of it” instead of understanding the true reason behind it will only take a course and conceptual learning so far. I’ve seen clickers and group discussions incorporated into my courses over the past five years that varied on a range from extremely effective and engaging to the exact opposite.

The types of questions or problems for students to answer were also extremely important to students’

perceptions of the use of active learning techniques. One student stated the following:

It depends on the types of clicker questions asked. Sometimes, the clicker questions are too easy and the answer can be found in the textbook. The questions should be a bit more challenging to test our ability to apply the concepts so that we could discuss with the professor along with the class about how to approach such problems.

With respect to group discussion, students indicated that the professor should have structured questions and

speak to how students should be interacting with one another in their group. Fourteen students commented that in most situations, the effectiveness of group discussions was dependent on the students in the class. In some circumstances, students experienced excellent discussion with their peers, but in other situations, their peers would sit silently and not participate. A student expressed the following view: “Group activities are only useful when there is structure as to what the group should be doing and clear instructions.”

Discussion

Although the sentiment of the comments varied dramatically, the

TABLE 1

A summary of students’ written comments regarding the use of active learning techniques in lecture.

Category	Students’ perceptions of active learning techniques	Number of times it was referred to in the comments		
		General	Clickers	Group discussion
Negative comments	Waste of time and money	6	35	18
	Used solely for attendance	—	6	—
	Not helpful because students tend to guess or copy one another	—	5	—
	Prefer traditional methods of lecturing	6	—	1
Positive comments	Keep students engaged and help them to pay attention in class	1	15	1
	Provide feedback for students and instructor	—	15	2
	Helps with understanding	5	22	5
	Discussions with peers reveal students’ misunderstandings	1	7	5
	Good for big classes	1	8	—
Conditional comments (effectiveness depends on another factor)	How the instructor uses these techniques is important	6	14	2
	Need for questions that are challenging, relevant and integrated well within lecture	2	13	—
	Need for structure/instruction with group discussion	—	—	8
	Effectiveness depends on the students in the class	2	—	14

conditional comments reinforced what was written by students with negative and positive perceptions. Students expressed that how an instructor uses active learning techniques in lecture is tightly knit to their effectiveness, which parallels Michael's (2006) comment that "active learning doesn't just happen; it occurs in the classroom when the teacher creates a learning environment that makes it more likely to occur" (p. 164). Similarly to findings of Perkins and Turpen (2009), students in this study held positive perceptions of instructors who used active learning techniques to help foster understanding, to provide feedback, and to encourage peer interaction. Unfortunately, students who had negative experiences with active learning techniques referred to them as a waste of lecture time and their money and failed to appreciate the potential value these techniques could offer their learning. Mazur (2009) indicated that "it is not the technology that matters but the pedagogy" (p. 51), which has served as an impetus for scholars to create and test particular approaches or frameworks to guide instructors in the effective implementation of such techniques (Crouch & Mazur, 2001; Mayer et al., 2009; Smith et al., 2009; Turpen & Finkelstein, 2009).

Students commented that the effectiveness of active learning techniques depends not only on instructor use, but also on student use. As noted by Trees and Jackson (2007), "putting clickers in the hands of students, however, does not guarantee an engaged class" (p. 25). These findings support previous literature that stresses the importance for instructors to inform their students as to why they are using active pedagogy

and to review the role that students play in their own learning (Meyers & Jones, 1993). In this study, students commented on the need for instructors to provide detailed instructions as to how students should interact with one another in lecture and why this interaction is beneficial for their own learning.

There was a statistically significant shift between the perceptions of students in third year and those in fourth year and above. Fourth-year students' negative views of the use of active learning techniques may be attributed to their early exposure to clickers at UBC, where clickers were used sparsely and instructors were less experienced with their use. For this group of students, the use of in-class active learning techniques preceded the involvement of the Carl Wieman Science Education Initiative (CWSEI) at UBC. The CWSEI has been helping to transform over 70 science courses at UBC, and one of the goals of this initiative is to improve the quality of the implementation of active learning techniques. Scholars within UBC have been working with and providing pedagogical frameworks for science faculty to incorporate more effective means of in-class active learning techniques such as peer instruction, small-group discussions, and in-class worksheets (Crouch & Mazur, 2001; Smith et al., 2009; Turpen & Finkelstein, 2009). At the time that this study was conducted, students in third year or below would have experienced active learning in courses that have been transformed over the past 4 years. They might hold a more positive perception of active learning techniques because they are more familiar with their use and because faculty and staff at UBC have had the opportunity to

improve and refine their instruction with these techniques.

Finally, this study both reinforces and contradicts previous research indicating female students' preference for the use of in-class active learning techniques (Meyers & Jones, 1993; Seymour & Hewitt, 1997). Females express feeling more isolated in large science lectures and struggle more often than their male peers with their academic and personal self-confidence (Seymour & Hewitt, 1997). The use of in-class learning techniques address these issues by increasing female students' interaction with their peers and by providing essential feedback on their progress in a course (Seymour & Hewitt, 1997; Smoot-Hyde & Gess-Newsome, 2000). On the other hand, this study finds that some females hold negative perceptions regarding the use of in-class group discussions. It is worthy to note, however, that the females' comments were about their peers' lack of focus or participation and not inherently on the active learning techniques themselves.

Conclusion

Students' experiences with in-class active learning techniques are diverse. This research revealed why students hold positive, negative, or conditional perceptions of the use of these techniques in undergraduate science courses. This study was a broad overview of science students' perceptions, and conducting more focused research in the future will help explore the similarities and differences between students' experiences and perceptions in various disciplines and courses. Despite this, students' perceptions and advice can help to inform staff and faculty as to how they might improve their teaching and assessment. In particular, students recom-

mended that professors use clicker or group discussion questions or activities that

- push students to work with one another,
- are challenging and relevant to the course material, and
- add value to and are integrated well within the lecture material.

Instructors are not the only factor that influence whether active learning techniques are facilitated appropriately in lecture. Students play an integral role in the classroom, and their perceptions deserve consideration. Students' comments are insightful and can be consulted to improve the implementation of in-class active learning techniques in undergraduate lectures. ■

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