

Student Evaluation of Clickers in a Combined Dental and Dental Hygiene Periodontology Course

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Abstract: The purpose of this report is to describe the general use of clickers as an active learning tool and how they were used in teaching a combined periodontology course for second-year dental and junior dental hygiene students. A survey was used to capture student perceptions following completion of the course. Specific domains were active learning, improved performance, and expectations. The survey response rate was 94.5 percent (121/128). Descriptive analyses showed that, in the domain of active learning, 102 (84.3 percent) agreed/strongly agreed that the use of clickers made the lectures more interactive; sixty-six (54.5 percent) agreed/strongly agreed that the clickers made them focus; and ninety-two (76 percent) agreed/strongly agreed that the clickers encouraged active participation. In the domain regarding improved performance, sixty-three (52 percent) agreed/strongly agreed that the review sessions utilizing clickers helped them prepare for tests. In the domain of expectations, ninety-three (76.9 percent) had a better idea of what to expect on the examination due to the use of clickers, and seventy-three (60.3 percent) thought that the clickers should be used in future semesters for this class. In addition, faculty members appreciated the greater participation afforded through the use of clickers to obtain a better understanding of the students' grasp of course content. Learning theory suggests that students must actively engage in the learning process in order for meaningful learning in the form of critical thinking and problem-solving to take place. In this study, students confirmed that the use of clicker technology encouraged their active participation in a periodontology course.

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Active learning in dentistry is not a new concept. Haden et al., in a study supported by the American Dental Education Association Commission on Change and Innovation in Dental Education (ADEA CCI), proposed principles to shape the dental education environment.¹ These principles were critical thinking, lifelong learning, humanistic environment, scientific discovery and integration of knowledge, evidence-based oral health care, assessment, faculty development, and the health care team. Among these, critical thinking is described as a thread that weaves together the many complex educational experiences of students. Critical thinking is foundational to teaching and learning any subject. To encourage critical thinking, it is important to actively engage students in their learning process. The interaction between students and teachers tends

to be very minimal in a traditional lecture format. Active learning occurs when the teacher creates a student-centered learning environment.²

According to Guthrie and Carlin, modern students are primarily active learners, and lecture courses are increasingly out of touch with how students engage their world.³ With the increasing access to and use of technology, students are creating and engaging their social world shaped by technology that surrounds them. Similarly, students wait for a familiar way to interact in the classroom.³ Chickering and Gamson developed seven principles of good practice in undergraduate education and list active learning as one of the seven principles.⁴ While their research was done in undergraduate education, the same principles can be seen to apply to professional education.

It has been suggested that the use of clickers may be one way to encourage active learning in large group courses through enhanced attention, engagement, and thinking.^{5,6} Many instructors have adopted clicker technology to compensate for the passive, one-way communication inherent in lecturing and the difficulty students experience in maintaining sustained concentration.⁷ “Clicker” is the commonly used word for personal response devices or audience response systems due to their resemblance to the television remote. Clickers are also referred to as classroom response system, personal response system, classroom communication system, group response system, audience response system, electronic voting system, audience-paced feedback system, and classroom network.⁷⁻¹² Students use their clickers to transmit their answers by pressing buttons on the keypad. Each clicker unit has a unique signal, so that the answer from each individual student can be identified and recorded. When polling is complete, answers from the entire class are displayed on the projection screen usually in the form of a bar graph. The answers displayed are completely anonymous.

Studies have been conducted in a variety of disciplines exploring the effectiveness of clicker technology to enhance the teaching and learning environment.^{5,6,13-16} When used as a learning tool in a physiological chemistry/microbiology course, 98 percent of the students reported an increase in attention.¹⁴ The use of clicker technology in dental education has been specifically examined.¹⁷⁻²¹ Clickers have been used in “quiz bowl” format, with 77 percent of the students reporting that the clickers motivated them to learn.¹⁷ When used to review topics in the dental curriculum, students said they liked the clickers and preferred their use to being asked questions during lecture.¹⁸ An increase in test scores was noted with the use of clickers in a preclinical operative dentistry course, while a second-year biomaterials course with clickers showed no difference in students’ test scores with or without the use of clickers.^{19,20}

Clickers have been used as a management tool to engage students in a large classroom by providing a positive and active atmosphere.^{6,7,22,23} Use of this technology varies widely and includes varying standard lecture classes with periodic breaks to assess student opinions or understanding related to lecture material.^{6,7} Clickers by nature increase participation by allowing students to respond to questions asked by the instructor.^{5,7,20} The clickers are an effective way to implement questioning methods in large classrooms.²¹ The traditional style of questioning is

harder as class sizes increase. Students in large classes are often hesitant to speak up for fear of making mistakes and embarrassing themselves or receiving disapproval from their peers.^{7,24,25} Clickers facilitate communication with a classroom full of students by allowing potentially anonymous and instantaneous class surveys to be displayed in the form of a graph on a projection screen. Such technology has the potential for pedagogical use for innovative faculty members.²⁶ Clickers can also be used to emphasize important concepts at the beginning of the class. Periodic breaks by utilizing clickers may alleviate student fatigue. Clicker questions are ideal for reviewing as an active way to demonstrate whether the point intended by the faculty member has gotten across.⁷ In general, students have reported that the clickers are fun and their use tends to liven up the classroom.⁷

When originally introduced in the 1960s, clickers were limited in their use mainly due to their expense. Since then, clickers have evolved from large wired devices to sleek wireless tools.²⁷ The devices now are more powerful and user-friendly than in the past, and further advances in hardware and software continue to make the technology increasingly efficient while being cost-effective and accessible to students and teachers alike.²⁵ Two primary technologies exist currently to transmit the data from the keypads to the base station: radio frequency (RF) and infrared frequency (IR). IR systems are better suited for small groups, while RF systems work better in large groups as they are not likely to suffer interference when multiple keypads are used simultaneously.²⁷ The clickers used in our study worked on the RF technology.

In studies of clickers in classrooms, faculty members report less sleeping by students, more discussion, and improved alertness during class.^{7,15,19,28} An increase in attendance has also been repeatedly documented.^{7,29,30} While there are many advantages to the use of clickers in the classroom, their use has been shown to also pose some challenges. Integrating technology into a large lecture class can be challenging and an interesting journey for both instructors and students. As with any new technology, it takes a reasonable time for faculty to adapt to the system. Faculty members who receive training in how to use the clicker technology are able to adapt more easily compared to those who use the system without the benefit of training and support. Even with the training in technology, additional effort is needed in writing new questions that require high levels of reasoning and integration.²⁷

While this topic has been extensively studied in other disciplines, very little has been published on it in dental education since 2008. Our study is unique in that it included both dental and dental hygiene students in a combined periodontology course. The purpose of the study was to determine student satisfaction with the use of the current clicker technology in a combined periodontology course with dental and dental hygiene students to determine if students perceived it improved the teaching and learning environment. Our research questions were as follows: 1) What are dental and dental hygiene student perceptions of the use of clicker technology in a combined periodontology course? and 2) Does clicker technology result in increased active learning in a large classroom setting?

Methods

This study utilized a survey research design to explore the perceptions of dental and dental hygiene students with regard to the use of clicker technology in the classroom setting. Those invited to participate were a cohort of 128 second-year dental and junior dental hygiene students enrolled in a combined course on periodontology. The class consisted of 101 dental students and twenty-seven dental hygiene students. The study was reviewed and determined exempt by the University of Missouri-Kansas City Social Science Institutional Review Board.

The clicker technology used in the course was part of a university-wide pilot project. As the class size was large and classes were designed primarily with two fifty-minute lectures, the clickers were utilized as an active learning tool. The instructors were asked to insert questions throughout the traditional lecture format. The faculty members posed predominantly simple multiple-choice questions to investigate the progress of student knowledge and understanding, and the questions included a combination of critical thinking, problem-solving, and factual recall. Table 1 shows some of the questions asked utilizing the clicker technology. Students were able to respond anonymously, thereby eliminating the fear experienced by some students of speaking up in a large classroom setting. The number of correct and incorrect responses was viewed immediately in a bar graph format.

Coefficient alphas were calculated for each of the survey domains. Cronbach's alpha is a commonly used test of reliability developed by several research-

Table 1. Questions asked during the lecture utilizing clickers

1. The sulcular epithelium lacks the stratum corneum and the stratum _____.
 - a. basale
 - b. spinosum
 - c. granulosum
 2. A patient has an area of coronal gingival overgrowth (coronal to CEJ) on the facial of tooth #5 of 2 mm with a probing depth of 4 mm. The amount of attachment loss on the facial of this tooth is:
 - a. 0 mm
 - b. 2 mm
 - c. 4 mm
 - d. 6 mm
 3. Host cells produce collagenase that break down collagen into fragments that ____ chemotactic.
 - a. are
 - b. are not
-

ers in the early 1900s and named by Cronbach,³¹ the first writer to recognize its general usefulness. Internal reliability is a measure of internal consistency or reliability of a psychometric test score (e.g., student perceptions) with a number ranging from zero to one.

The survey used in this study was an adaptation of research conducted by Roberts,³² and items specific to clickers were developed based on an extensive review of the literature. Content validity was established through the use of experts on survey research and experts on clicker technology. The items on the survey were edited by the faculty and technology experts for content relevance and for clarity and simplicity. Three main domains were explored: 1) active learning, 2) improved performance, and 3) expectations. The remaining questions explored were labeled other/miscellaneous. A Likert scale of 1 (strongly disagree) to 5 (strongly agree) with 3 for "no opinion" was used. Descriptive statistics were used to analyze survey results. An independent two samples t-test was conducted to compare dental and dental hygiene student responses as reported in each of the three domains and the miscellaneous group.

Results

The response rate on the survey was 94.5 percent (121/128). Demographic information on the participants is shown in Table 2. The students were predominantly white females in the age range of twenty-three to twenty-five years. Internal consis-

Table 2. Demographics of dental and dental hygiene students participating in study

	N (Percentage)
Gender	
Male	44 (36.4%)
Female	69 (57.0%)
Age in years	
20-22	15 (21.4%)
23-25	61 (50.4%)
26-30	29 (24.0%)
Over 30	8 (6.6%)
Race/ethnicity	
White	99 (81.8%)
Asian and White	1 (0.8%)
Black/African American	8 (6.6%)
American Indian/Alaska Native and Black/African American	10 (8.3%)
Black/African American and White	2 (1.7%)
American Indian/Alaska Native and Black/African American	1 (0.8%)
Hispanic or Latino	5 (4.1%)
Program	
Doctor of Dental Surgery	89 (73.6%)
Dental Hygiene	24 (19.8%)

Note: Race/ethnicity categories are those of the U.S. Census Bureau. Percentages may not total 100 percent due to nonrespondents and/or rounding.

tency estimates of reliability were computed for the three domains, and the resulting coefficient alphas ranged from 0.768 to 0.884, which is considered in the acceptable range. Using guidelines proposed by Nunnally,³³ an alpha of at least 0.70 is considered adequate for an instrument in early stages of development.

Descriptive results of the survey are shown in Table 3. For the domain of active learning, 84.3 percent of the students agreed/strongly agreed that the use of clickers made the lectures more interactive than the traditional format. The students also agreed/strongly agreed that the use of clickers required them to focus more (54.5 percent) and actively participate (76.0 percent) in class. A large number of students (49.6 percent) disagreed/strongly disagreed that the use of clickers helped small-group discussion. For the domain on improved performance, there were mixed responses to the questions about whether the use of clickers helped the students master the course material, improve test scores, and increase interest in the class. A large number of students (48.8 percent) dis-

agreed/strongly disagreed that they attended the class more regularly due to the use of clickers. A large group of students (52.1 percent) agreed/strongly agreed that the use of clickers for review sessions helped them prepare for tests. For the domain of expectations, 76.9 percent of the students agreed/strongly agreed that the questions posed using clickers gave them a better idea of what to expect on examinations. A majority (60.3 percent) were positive about the overall use of technology and reported that the clickers should be used in future semesters for this class. A majority (66.1 percent) also agreed/strongly agreed that the instructors used the technology efficiently to enhance teaching and learning.

The final group of questions addressed miscellaneous topics, some of which related to technology. Regarding other classes in the School of Dentistry, 41.3 percent agreed/strongly agreed that more instructors should use the clicker technology. On the question of whether too much time was spent on the use of clicker technology, 40.5 percent agreed/strongly agreed. On the question regarding the clicker fees, a majority (52.9 percent) disagreed/strongly disagreed that the fee for the clickers should be included in the current equipment rental and usage fees.

Because of the combined nature of the course, comparative analyses were conducted. A two-group t-test compared dental and dental hygiene students' survey responses and found significant differences in domain 1 (active learning: $p=0.003$) and domain 3 (expectations: $p=0.015$) and miscellaneous ($p=0.023$). The domain of improved performance ($p=0.337$) did not result in a significant difference between groups.

Grades were compared for the dental hygiene and dental students with and without the use of clickers. The dental hygiene class was integrated into this course for only two years, with the clickers being used in the second year. Dental student grades from the past two years are shown in Table 4. A two-tailed t-test was used to compare the average scores between the dental classes with the two modes of instruction ($p<0.001$). The difference between traditional lectures and lectures utilizing clickers was 2.68 (95% CI: 1.44 to 3.92). The dental students who utilized clickers in the course did not perform as well as those in the traditional lecture. Grades for the dental hygiene students are shown in Table 5. For the dental hygiene students, the average score improved in the class that utilized clickers (difference -2, 95% CI: -6.33 to -2.33). A small improvement was

Table 3. Descriptive analysis of students' perceptions for each domain tested (N=121)

	Disagree/ Strongly Disagree	No Opinion	Agree/ Strongly Agree
Active Learning			
The use of clickers made the lectures more interactive than traditional formats.	11 (9.1%)	6 (5.0%)	102 (84.3%)
The use of clickers made me focus more in class.	28 (23.1%)	25 (20.7%)	66 (54.5%)
The use of clickers made me actively participate in the class.	12 (9.9%)	13 (10.7%)	92 (76.0%)
The use of clickers facilitated small-group discussion.	60 (49.6%)	26 (21.5%)	33 (27.3%)
Improved Performance			
The use of clickers helped me improve test scores.	29 (24.0%)	47 (38.8%)	43 (35.5%)
Due to the use of clickers, I attend class on a more regular basis than I would otherwise.	59 (48.8%)	22 (18.2%)	38 (31.4%)
The use of clickers helped me master the course material.	47 (38.8%)	40 (33.1%)	32 (26.4%)
The review sessions utilizing clickers helped me prepare for the tests.	16 (13.2%)	38 (31.4%)	63 (52.1%)
Using the clicker technology heightens my interest in whatever else we do during class.	36 (29.8%)	44(36.4%)	39 (32.2%)
Expectations			
The use of clickers will help me retain information longer.	44 (36.4%)	39 (32.2%)	36 (29.8%)
I had a better idea of what to expect on the examinations due to the use of clickers.	15 (12.4%)	11 (9.1%)	93 (76.9%)
I think the clickers should be used in future semesters for this class.	15 (12.4%)	31 (25.6%)	73 (60.3%)
How positive is your overall use of the technology?	18 (14.9%)	27 (22.3%)	73 (60.3%)
The instructors used the clicker technology efficiently to enhance teaching and learning.	9 (7.4%)	29 (24.0%)	80 (66.1%)
Miscellaneous			
The clicker technology worked well each class period.	94 (77.7%)	12 (9.9%)	13 (10.7%)
The clicker fee should be included in our equipment rental and fees.	64 (52.9%)	13 (10.7%)	42 (34.7%)
Too much class time was spent on the use of clicker technology.	39 (32.2%)	30 (24.8%)	49 (40.5%)
More instructors at the UMKC SOD should make use of the clicker technology.	35 (28.9%)	33 (27.3%)	50 (41.3%)

Note: Numbers may not total 121 and percentages may not total 100% due to nonrespondents.

Table 4. Comparison of grades earned by dental students in traditional delivery versus use of clickers

Graduating Class (Year Course Offered)	Mode of Instruction	N	Average Score in Percentage (SD)	Grades			Difference (95% CI)	Two Group t-test
				As	Bs	Cs		
2012 (2010)	Traditional lecture	98	94.7% (4.53)	92.9%	7.1%	0	2.68 (1.44 to 3.92)	p<0.001
2012 (2011)	Clickers	101	92.0% (4.36)	77.2%	22.8%	0		

Table 5. Comparison of grades earned by dental hygiene students in traditional delivery versus use of clickers

Graduating Class (Year Course Offered)	Mode of Instruction	N	Average Score in Percentage (SD)	Grades			Difference (95% CI)	Two Group t-test
				As	Bs	Cs		
2012 (2010)	Traditional lecture	28	88.8% (8.59)	78.6%	17.9%	3.6%	-2 (-6.33 to -2.33)	p=0.36
2012 (2011)	Clickers	28	90.8% (7.56)	82.1%	14.2%	0		

Note: Percentages for 2012 (2011) may not total 100 percent as one student withdrew from the course.

also seen as assessed by an increase in the number of students who scored an A grade and a decrease in students who scored B and C grades. The difference in the average scores between the classes was not statistically significant with a p-value of 0.36.

Discussion

Thinking during any class generally occurs as students build connections between new and existing knowledge that subsequently determine how they will use the information. Although an interactive learning process involves both attentiveness and engagement, students flow naturally from one to another.⁵ Promoting active learning in large classes is very challenging, so many lecturers end up delivering information in a traditional lecture format with minimal student interactions. Engaging small groups within a lecture may be a more effective means of promoting active learning.¹⁵ However, in large classes, technologies such as clickers provide another method for promoting active and engaged learning. Duggan et al. used clickers in a cohort of fifth-year medical students to teach consecutive forty-minute lectures on two clinical topics.¹³ One group received clickers for both the topics. The other group received traditional teaching only. Independent observers assessed student behavior during the lectures and found that only the sessions that utilized clickers had an increased participation from the students. This finding is consistent with the results of our study, in which a majority of the students agreed that the use of clickers made the lectures more interactive, made them focus more in class, and made them actively participate.

The primary investigator for this study (KMS) has co-taught this course for the past seven years. In comparing teaching the course with and without clickers, this faculty member observed that, prior to the utilization of clicker technology, students who answered questions in class tended to be the same from week to week. Reluctance to ask questions was possibly further complicated by the fact that this was a combined dental and dental hygiene course, again making the case for this type of technology for encouraging student engagement. From this faculty member's perspective, one of the best features of using clickers was the ability to see how all students responded to questions and thus determine content areas that needed further discussion and explanation. Thus, active participation by students in this study led to improved teaching strategies as all the faculty

members were able to customize instruction based on weak areas as identified through clicker responses.

Another study found that use of clickers increased discussion in the classroom.³⁴ In an undergraduate introductory genetics course, students who answered clicker questions following a discussion with their peers were more likely to pick the correct answers. In that class, following each question the instructors discussed the question and the correct answer with the class, but there was no small-group discussion involved, which explains the students' response.

Clickers have also been shown to dramatically improve lecture attendance and improve quiz performance initially and up to one month after the lectures.^{7,29,30} Attendance was mandatory in the class in our study, and only two excused absences were allowed. Although the clickers could be utilized to take attendance, the instructors used a manual method to take attendance each class period. This was mainly due to the fact that a few students forgot to bring clickers each class period or the clickers were not functioning. The clickers were not utilized to administer quizzes but were used for review sessions prior to examinations. Review sessions are considered useful in preparation for exams, so instead of the traditional review session conducted in past years, clickers were used to pose questions in the same format as a test. Feedback from students regarding the use of clickers for the review sessions was positive, with 52 percent agreeing or strongly agreeing that the review sessions utilizing clickers were helpful. A large percentage of the students (76.9 percent) also felt that they had a better idea about what to expect on the examinations due to the use of clickers.

Typically, active learning leads to increased engagement and better performance on course exams.²¹ However, in our study, in comparing the overall grades of the class that utilized clickers with that of the previous year in which the clickers were not utilized, we found that the dental students performed poorly during the year the clickers were utilized. In contrast to the dental students, the dental hygiene students showed an improvement in course grades between the previous year when clickers were not utilized and this class. Attributing course success to one factor (clickers) and comparing classes from year to year is not easily done since the educational environment involves a host of variables, e.g., overall academic achievement of a particular class from the start, student preparedness in foundational knowledge prior to taking a course, and amount of time

spent studying during the course. It was the course director's perspective that the dental student class utilizing clickers was not as academically strong as in the preceding year, which may have contributed to the study findings. In regard to the dental hygiene student results, it could be that the ability to respond anonymously in a classroom environment in which they might feel somewhat intimidated by the dental students resulted in better outcomes.

Uses of low tech methods such as show of hands, applause, or audible feedback have several disadvantages.³⁵ For example, lack of privacy may prevent honest votes, time constraints may prevent accurate estimates, and overall trend of student responses is only apparent to the instructor.⁶ The clickers encourage participation of students who would not ordinarily participate, either due to being unsure of themselves or because some students tend to dominate, making participation difficult for others.²⁷

Our students agreed that they had a better idea of what to expect on the examinations as a result of using the clickers. This is likely due to the fact that the questions used to poll the students in class were in a similar format to the test. Dental students participating in this study had not been exposed to clicker technology at the dental school. Regarding future use, a majority of them agreed or strongly agreed that the clicker technology should be used in future semesters for this course. The students also agreed that the faculty member utilized the clicker technology efficiently to enhance teaching and learning. Since there were several instances in the semester when students forgot to bring their clickers to class, it is encouraging that applications are being explored for mobile devices for use as an audience response system.^{36,37} Because the majority of students already bring their mobile devices (phones, tablets, etc.) with them to the classroom, these mobile applications would assist in alleviating the issue of students' forgetting their clickers. There were also instances when the clickers did not work. Most of the time, it was something as simple as replacing a battery. It was a rare occasion where the device malfunctioned and needed to be replaced.

This study was unique in that we had a combined class of dental and dental hygiene students. A comparison of the two groups revealed that the dental hygiene students significantly favored the use of clickers in the domains of active learning and expectations. One explanation for these differences may be a result of the dental hygiene students' having

more exposure to technology in their program as the dental hygiene faculty members at this school tend to be more robust users of various types of technology in their teaching and learning than the dental faculty members.

Although clickers are considered generally advantageous, they are associated with some limitations. One of the challenges with the use of any technology is reliability. Although the software utilized in this study worked very well, technical glitches with the keypads not working all the time were encountered. Since the faculty member in this course had a backup plan for taking attendance and did not utilize the clickers to administer tests, it did not have a significant impact on this course. Such glitches, however, can be frustrating and time-consuming. A majority of the students agreed that the clicker technology did not work well each class period. This was partly because some of the clickers used to teach this course were found to be defective. The defective clickers were replaced. Keypads are also bulky, and transporting a large number of keypads is challenging. Although less expensive than when they were first introduced, using clickers in a course requires a considerable investment. The software associated with this particular clicker was purchased by the university, but the keypads were approximately forty dollars each. The faculty member therefore polled the students to evaluate their perception if the cost of the keypad should be included in the dental instrument usage fee. A majority of the students disagreed with this option. Questions about how clickers are to be paid for and who is responsible for replacements are topics that need further evaluation.

A few students agreed that more instructors at the School of Dentistry should utilize the clicker technology in their classes. At the time this survey was conducted, this combined periodontics course was the the only dental course that utilized clickers. However, we feel that if more faculty members utilized this technology, the cost for the students may be better justified. Another possible limitation relates to the finding in one study that lectures using the clickers were difficult to prepare.¹³ The instructors in our course spent approximately four to six hours learning how to use the technology including how to conduct data collection. Additional time was also needed in the classroom to allow students time to read, think, and respond to questions presented in the clicker format. Given these time constraints, the faculty members adapted the lectures accordingly.

Conclusion

The utilization of clickers in a large combined dental and dental hygiene course on periodontology was perceived positively overall by both students and faculty as a tool to keep the students actively engaged in a large classroom environment. Learning theory posits that learning can only take place when the learner actively engages, and our study supports the idea that clicker technology promotes active learning. With multiple decisions being made in dental education today about how to use technology for learning and how to actively engage students, we found that clickers offered a fun, exciting, and entertaining way to actively engage students in a large classroom. We also felt that it was a positive way to integrate dental and dental hygiene classes in a cohesive manner.

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