

The Use of an Audience Response System in a Dental Gross Anatomy Practical Exam.

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ABSTRACT

Background: Traditional methods for administering and scoring gross anatomy practical laboratory examinations are time and resource-intensive and can be susceptible to errors in grading. Alternative approaches, such as audience response systems (e.g., clickers) and computerized scoring, appear to hold promise to improve the examination experience for students and improve the efficiency and accuracy of grading.

Method: To assess perceptions of using such systems, two cohorts of students who completed the gross anatomy practical examination using clicker technology at the University of Detroit Mercy School of Dentistry were invited to complete the survey.

Results: A total of 155 students completed the study. Responses reflect a mostly positive appraisal of the use of clicker technology by most students. In particular, students reported that submitting responses was easier and that the speed of grading and feedback on examination performance improved considerably.

Conclusion: Based on the survey results, the use of audience response systems appears to have more benefits than liabilities and seems to be a worthwhile technology to use for practical laboratory examinations.

KEYWORDS: Gross Anatomy, Practical Examination, Clickers, Audience Response System.

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INTRODUCTION

Dental and medical students in American universities learn human gross anatomy during their first year [1]. Testing student knowledge of anatomical structures in the gross anatomy laboratory can be a challenge for faculty and staff [2,3], especially if multiple assessments are required each semester.

Steeple chase or Spotter Practical Exam 4 is the traditional method of choice used in many Gross Anatomy practical examinations.

It consists of timed stations -similar to musical chairs - that have an identification of a tagged structure on a prosected specimen, model, or diagram [2-5]. The time allowed for each question station is approximately one minute, during which students write their answers in the name of the tagged structure before an audible signal is sounded indicating that they can move to the next station. Spotter gross anatomy examinations have also been conducted online through the use of

high-resolution photographs [6,7].

In both cases, however, grading is done manually. Such an approach to grading is time and resource intensive and is fraught with potential errors, particularly when the grading is completed by more than one faculty member. Efforts to address grading challenges have been made and include the use of a multiple choice response formats in lieu of written textual responses [2,8] and computer-based online administration⁷, in which responses are electronically graded and feedback immediately provided to the student. Computer administrated examinations that give students expedient feedback on their performance have been found to be preferred by students [9,10] over traditional examination formats and grading.

In recent years, a new option has become available that appears to hold promise. Called Audience Response Systems (ARS; also known as clickers), this technology involves hand-held devices that are remotely linked to a computer. Students are able to enter their responses to each examination question electronically using the device. The responses are transmitted to a secure computer on which software is installed that records and grades the responses. ARS has been found to improve the analysis of student responses, aid students in the application of information learned in class, and to be a helpful tool for formative assessment [11,12].

Given the potential of ARS to improve the administration and grading of gross anatomy practical examinations, we were interested in implementing it and gathering data from students to assess its perceived benefits and liabilities as well as student satisfaction with the technology. In particular, two cohorts of students in the head and neck anatomy course taught to first year dental students at the University of Detroit Mercy School of Dentistry were asked to complete an anonymous survey designed to collect information on their experience of using the technology after they had completed applied didactic practice examinations (details on the sample and survey are provided in the methods section). In preparation for the examination, all students

were provided with some instruction on how to use the ARS technology and given the opportunity to take a mock examination so that they could develop proficiency in entering and submitting responses. The specific ARS employed was the system from Turning Technologies, LLC, in which each student has a small remote control or “clicker” that is used to respond to questions presented via a computer and a projector. The hardware (Response Card, RF receiver) and software (Turning Point) was purchased from Turning Technologies LLC (<http://www.turningtechnologies.com/>) and installed on a designated laptop computer. The remote control devices (Response Cards) were also purchased and distributed to the students (see Figure 1 for a picture of the remote control device used). For the mock examination, students were supplied with “answer sheets” that consisted of a numbered list of anatomical parts organized alphabetically. Students were required to use the list to identify the correct anatomical part for each question, write down the number of the parts (done in case there was a problem with the technology), and then enter the number into the clicker device.

METHOD

Participants: A total of 155 students (92 females, 63 males, mean age= 24.97 years, SD= 4.02) volunteered to complete an online survey after completing the anatomy examination. Of these students, 100 had completed the survey in 2015, while the remaining 55 students completed the survey in 2019.

Survey Instrument: The survey instrument was developed based upon a review of literature on the use of ARSs in didactic examinations. The survey consisted of 11 items on which students used a five-point response scale to rate their degree of agreement with the item. The item content and response scale can be seen in Table 1. In addition, students were asked to provide written responses to two questions that pulled for their perceptions of the most useful feature (i.e., “List the most useful features about using clickers during the

gross anatomy laboratory from your perspective”) and the least useful features (i.e., “List the least useful feature about using clickers during the gross anatomy laboratory exam from your perspective”) of the clicker technology. Prior to administration, the survey was evaluated for content validity by a panel of dental educators and students [13] and found to be satisfactory.

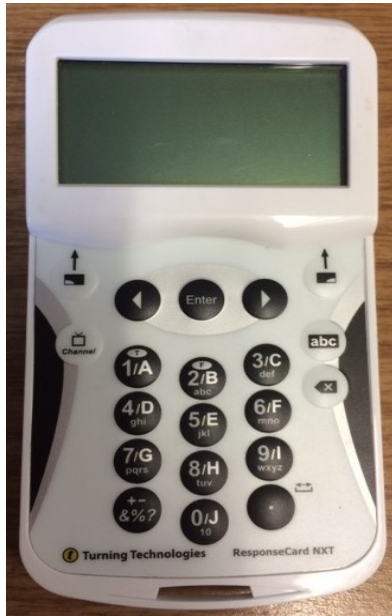


Fig. 1: Picture of the Clicker Device Used by Students to Enter Answers.

Procedure: At the end of the semester, the survey was distributed to students electronically through Qualtrics®. Students who completed the survey did so voluntarily and with no compensation provided for their participation.

Ethics Approval: The survey was approved by the University of Detroit Mercy Institutional Review Board for the protection of Human Subjects (IRB #X).

RESULTS

For the 11 items using a response scale format, the response options were numerically coded (1= Strongly Disagree, 2= Disagree, 3= Neither Agree nor Disagree, 4= Agree, and 5= Strongly Agree) and means and standard deviations were computed. Table 1 presents the descriptive statistics as well as the response frequencies for all 11 items. Examination of the information in the table shows a fairly wide dispersion of responses across the items. Overall, it appears that the

use of the technology was a positive experience for most students. However, questions asked about (a) the impact of the technology on grades, (b) the extent to which the use of clickers made response entry less overwhelming, and (c) whether students would recommend the technology for use in future examinations generated less consistent and less favorable responses from students.

Below is a succinct summary of the percentage of favorable responses (i.e., responses of agree or Strongly Agree) and unfavorable responses (i.e., responses of disagree or Strongly Disagree) for each item:

(1) For item “I had prior experience in utilizing audience response systems (clickers),” 86.5% of students responded Agree or Strongly Agree while 12.9% of students responded Disagree or Strongly Disagree. This indicates that a substantial majority of students had familiarity with the use of the technology prior to taking the head and neck anatomy course.

(2) For the item, “Entering responses with clickers was easy,” 77.3% of the student made favorable responses. In contrast, 14.9% of students responded unfavorably. This suggests that most students found the use of the clicker device to be easy to use.

(3) For the item “The clicker technology worked well when entering responses,” 89.6% of students responded in the affirmative while 5.1% responded unfavorably. Based on the responses, it is evident that the technology was reliable for the vast majority of the students.

(4) For item “I would prefer to enter responses using clickers only,” 47.7% of the students responded Agree or Strongly Agree and 35.3% responded Disagree or Strongly Disagree. This pattern of responses suggests that less than half the sample prefers the exclusive use of clickers to submit examination responses and a sizeable proportion of the sample is to the sole use of clickers for response entry.

(5) For item “I did not encounter technical difficulties during the exam,” 72.9% of students responded favorably while 18.1% responded unfavorably. This indicates that most students had no problems with the technology.

(6) To the item “Overall I am satisfied with clickers in the administration of the practical anatomy exam,” 67.8% of students responded Agree or Strongly Agree and 23.2% responded unfavorably. Most of the sample appears to be satisfied with the use of clickers, although the proportion of the sample that responded unfavorably is fairly high.

(7) To the item “Clickers help make my experience in entering answers less overwhelming,” 36.1% of the sample responded favorably while 43.2% responded Disagree or Strongly Disagree. This pattern of responses indicates that a large proportion of the sample did not find the use of clickers to be helpful in reducing stress associated with answer entry.

(8) To the item “Sufficient time was allocated to enter responses into the clicker pad,” 56.8% responded Agree or Strongly Agree, while 27.8% responded unfavorably. While these proportions show that more than half of the students responding to this item consider the amount of time to submit responses was adequate, the number of students who

responded unfavorably is quite high.

(9) To the item “Incorporating the clicker system in the lab positively impacted my grade,” 24.0% of students Agreed or Strongly Agreed and 24.7% of students responded with Disagree or Strongly Disagree. These proportions are relatively equal.

(10) To the item “The use of clickers allowed grades to be available to students sooner,” 82.5% of students responded favorably while 7.1% responded unfavorably. Clearly, the vast majority of students perceived the use of the clicker as facilitating faster grading and feedback.

(11) Finally, on item “I recommend the use of clickers in future anatomy lab examinations,” 60.0% of students responded Agree or Strongly Agree and 23.2% responded Disagree or Strongly Disagree. While the majority of students who responded to this item seem to endorse the use of clickers in the examinations, close to a quarter of the respondents responded unfavorably.

Table 1: Descriptive statistics and response frequencies of survey items using response scale formats.

Item	Mean	S.D.	Response Frequencies				
			SD	D	N	A	SA
I had prior experience in utilizing audience response systems (clickers) (n= 155)	4.08	1.1	9 (5.80)	11 (7.1%)	1 (0.60%)	72 (46.5%)	62 (40.0%)
Entering responses with clickers was easy (n= 154)	3.9	1.05	4 (2.60%)	19 (12.3%)	12 (7.8%)	73 (47.4%)	46 (29.9%)
The clickers technology worked well during entering responses (n= 154)	4.14	0.76	1 (0.60%)	7 (4.50%)	8 (5.20%)	92 (59.7%)	46 (29.9%)
I would prefer to enter responses using clickers only (n= 153)	3.18	1.32	19 (12.4%)	35 (22.9%)	26 (17.0%)	45 (29.4%)	28 (18.3%)
I did not encounter technical difficulties during the exam (n= 155)	3.77	1.1	6 (3.90%)	22 (14.2%)	14 (9.0%)	73 (47.1%)	40 (25.8%)
Overall I am satisfied with clickers in the administration of practical anatomy exam (n= 155)	3.58	1.21	12 (7.7%)	24 (15.5%)	14 (9.0%)	72 (46.5%)	33 (21.3%)
Clickers helped make my experience in entering answers less overwhelming (n=155)	2.9	1.32	27 (17.4%)	40 (25.8%)	32 (20.6%)	33 (21.3%)	23 (14.8%)
Sufficient time was allocated to enter responses into the clicker pad (n=155)	3.37	1.16	10 (6.5%)	33 (21.3%)	24 (15.5%)	66 (42.6%)	22 (14.2%)
Incorporating the clicker system in the lab positively impacted my grade (n= 154)	2.99	0.93	10 (6.5%)	28 (18.2%)	79 (51.3%)	28 (18.2%)	9 (5.8%)
The use of clickers allowed grades to be available to students sooner (n= 154)	4.1	0.85	0 (0.00%)	11 (7.1%)	16 (10.4%)	74 (48.1%)	53 (34.4%)
I recommend the use of clickers in future anatomy lab examinations (n= 155)	3.44	1.19	14 (9.0%)	22 (14.2%)	26 (16.8%)	68 (43.9%)	25 (16.1%)

Note: S.D.= Standard Deviation, SD= Strongly Disagree, D= Disagree, N= Neither Agree nor Disagree, A= Agree, SA= Strongly Agree. To compute the mean and standard deviation, each response category was assigned a numerical code where SD= 1, D= 2, N= 3, A= 4, and SA= 5. For response frequencies, the percent values reflect the percent of the total sample that provided each response for each item.

For the two items that prompted students to provide written responses identifying the most and the least useful aspects of the technology, responses were reviewed and grouped based upon similarity. For the most useful aspects, the most common responses were faster grading and performance feedback, improved efficiency in time usage and answer entry (e.g., less time needed to record responses), and ease of use of the clicker for entering responses. For the least useful aspects, the top responses were challenges in finding the correct number associated with a structure on the answer sheet, difficulties with using the clicker efficiently to check and change responses to questions, and difficulties effectively handling the materials and equipment during the examination (e.g., some students reported having problems handling a clipboard, writing the implement, answer sheet and clicker device).

DISCUSSION

It seems that students perceived so many advantages of using the clicker technology such as ease of entering answers and faster grading of exams. Audience response system has been used in other course examinations during the first year of dental school at the University of Detroit Mercy- School of Dentistry. Our results showed although the majority of the student had previous experience using clickers, and it worked well for them during the exam; there was moderate student satisfaction (56.6%) with this exam technology. This might be the case because there was a considerable percentage of students (43.2%) feeling stressed regarding the clickers answer entry. Even though, most of the students did not express any substantial concerns regarding the possible lack of time allocated for clicker entry or encountering technical difficulties.

60% of students favored the future use of clickers despite that less than half of the students preferred entering their response using clickers and they felt that did not positively impact their exam grades. Gross anatomy faculty were pleased for using the technology since it proved an easy and fast

solution for grading exams and finding patterns for student's answers.

Many studies have documented the successful implementation of the audience response system in active learning¹⁴⁻¹⁶ multiple choice examinations¹² The use of clickers is believed to increase student motivation, retention of information, and critical analysis of information presented in class¹⁷. However, the use of clickers in an anatomy laboratory practical exams is yet a unique initiative. This might be due to the relative new use of this technology and the time needed for the students to learn it and get used to it. The use of clickers in practical exams was halted during the COVID-19 pandemic due to initial lockdown and then to social distancing restrictions.

Several efforts have been made over the last decade to switch from hand grading anatomy examination to using computerized grading of anatomy laboratory exam¹⁸ using online anatomy exams [3,7].

CONCLUSION

The clicker's technology used in grading practical exams is an excellent educational technology to allow uniform assessment between all students. Many students have favored using this technology since it provided faster feedback of their results. Although of overall satisfaction with the use of this technology, some students perceived a higher because of stress during the exam. Pros are overcoming the cons of the use of ARS; the faculty will continue to implement in the gross anatomy course.

Declarations: Ethics approval and consent to participate: The authors declare that they have obtained the University of Detroit Mercy Internal Review Board (IRB# 1516-09) approval and granted an exemption from oversight for the protection of human subjects. The consent to participate was part of the IRB application. The participants had consent form emailed to them before participating in the study. Informed consent was obtained from all subjects

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Author Contributions

Each author has contributed to this manuscript.

M.A wrote most of the manuscript

F. H. assisted in writing the manuscript.

N.S. contributed to the material and methods and results.

D.M. did the statistical analysis and edited the manuscript.

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