Bring your own device technology: Preliminary results from a mixed methods study to explore student experience of in-class response systems in post-secondary education

Matthew NUMER
School of Health and Human Performance, Dalhousie University
Halifax, Nova Scotia, Canada

and

Rebecca SPENCER
Faculty of Graduate Studies, Dalhousie University
Halifax, Nova Scotia, Canada

ABSTRACT

This research examines the effectiveness of Bring Your Own Device (BYOD) technology in a post-secondary classroom. Despite recent advances in the technological tools available to educators, there is a significant gap in the literature regarding student efficacy, engagement and contribution to learning. This paper will present the preliminary findings of the first phases of an evaluation project measuring student interaction with BYOD technology in a large group setting. Employing a mixed methods design, the findings from two focus groups and two online surveys will be discussed. This project involved students in the Winter and Fall 2014 semesters of a fourth year Human Sexuality course which has enrolment of approximately 400 per semester. The findings suggest that BYOD technology contributes to student engagement and participation in the classroom setting. Further, the findings suggest that students are comfortable in using this tool, and perceived the experience as enjoyable.

Keywords
Education technology, Mixed methods, Post-secondary, Evaluation, Bring Your Own Device Technology (BYOD)

INTRODUCTION

A significant gap in the literature exists regarding the effectiveness of Bring Your Own Device (BYOD) technology in post-secondary classrooms. This research contributes to that gap by investigating the impact of BYOD technology in a large university course. Employing an exploratory mixed methods design, this research includes online feedback, focus groups, and a survey to understand the impact of BYOD technology on student learning experiences.

The changing landscape of post-secondary education toward the integration of technology as a standard practice of classroom engagement has increased the demand for innovative methods [1]. Amidst these demands, however, many universities have experienced significant budgetary constraints, which may inhibit technological progress, particularly at the individual instructor level [2]. In recent years Bring Your Own Device (BYOD) technology has gained popularity as a cost-effective means by which instructors can engage students and improve learning outcomes [3]. These changes in the classroom environment and student expectations have taken place over a relatively short period of time considering the history of education. Given this circumstance, research regarding the effectiveness of BYOD technology and its contribution to learning has not been well documented in the literature.

METHODS

The purpose of this study was to evaluate the use of BYOD technology in a large post-secondary course. The BYOD system in this study is Tophat. Tophat is a web-based application that eliminates the need for physical devices such as clickers for students to respond in real-time. The system employs a standard web site where users can answer questions in a variety of formats, and view their grades and feedback. Tophat is unique in its deployment as it relies on students' use of their own cellular devices, smart phones, tablets, or computers to respond to questions through text message, use of a web-based platform, or use of a downloadable smartphone application. In this course, Tophat was employed in a variety of circumstances, including in-class multiple choice questions, polling, creation of word clouds, matching, short answer, weekly discussion questions as homework

assignments, and tournament-style reviews prior to exams.

This research employs an exploratory mixed methods approach to investigate the impact and student experience using BYOD technology. The study population was recruited from a large course (approximately 400 students per semester) taught by the principal investigator in the winter and fall 2014 semesters. This is a fourth year Human Sexuality course in Health Promotion that is commonly taken as an elective by upper-year undergraduate students across many disciplines. This paper presents the first phase and preliminary results of a larger ongoing and planned research program exploring the impact of BYOD technology on active learning, critical thinking, and educational outcomes. The exploratory mixed methods design of this phase allows preliminary exploration of the potential impact of BYOD on student learning experiences, with qualitative data providing depth, context, and meaning, to quantitative data.

Qualitative Design
Qualitative data were collected using qualitative description as a methodology, the purpose of which is to explore a novel topic, gain understanding of participant perspective, and describe lived experiences [4]. Qualitative description was used to explore the potential impact of BYOD technology on student learning, benefits and limitations of the system, and the contribution of the program to the course environment. Qualitative description was employed through two methods: (1) online anonymous feedback using open-ended questions on the BYOD system; and, (2) semi-structured focus groups with students. The qualitative portion of this study was conducted with students in both the winter and fall semesters, and students were recruited through in-class announcements (on the final day of the course), and using the university's online course announcement and email system.

The online feedback portion involved inviting all enrolled students to respond to open-ended questions about how students perceive the BYOD program may have impacted learning or the classroom environment, as well as benefits and limitations of each aspect of the BYOD system. This portion of the study was conducted online using the BYOD system, which has to ability to designate those questions as anonymous, to avoid students feeling pressured to speak positively about their experiences. The focus group portion of this study involved recruiting a sub-group of students to engage in small semi-structured focus groups to discuss student experience with BYOD technology.

Two semi-structured focus groups lasting approximately 60 minutes were conducted. The focus groups were audio recorded and transcribed verbatim. Thematic analysis was conducted, using line-by-line coding and allowing common and meaningful experience to emerge from the data as themes [5]. This paper will include discussion of the focus groups held in winter 2014 only, as this project is ongoing.

Quantitative Design
Quantitative data were collected using Opinio online software (accessible through our university) to assess student satisfaction, active learning, and overall perceived impact of the BYOD technology. The survey involved combining and modifying three existing instruments that have acceptable reliability and validity [6]. These instruments included the Educational Practices Questionnaire, the Simulation Design Scale, and the Student Satisfaction and Self-Confidence in Learning instrument (copyright 2005) [6]. Permission to use these instruments was granted by the National League for Nursing [6]. We have modified the instruments from their original format in order to specifically address the BYOD technology. Further details of this portion of the study are detailed in the below section on findings. Descriptive frequency statistics are presented below. All students in the fall 2014 semester of the course were invited to take part in this portion of the study.

This study focuses on gaining an in depth understanding of student experiences with BYOD in a large classroom setting, including how the program is experienced and perceived by students, benefits and limitations of the program, utility of each program component, the extent to which students felt supported in using the program, how the program mediates the student/professor relationship, and how the program contributes to student self-confidence in learning and active learning outcomes.

FINDINGS

Qualitative Online Survey
The online survey asked a series of questions regarding the participants' experience using the BYOD system. The below describes the findings, which are divided into categories based on how the system was utilized. The first reflects participants' use of the in-class features of the program, followed by discussion of how users felt about weekly discussion questions and tournament features that were employed outside of class time.

In-class features: Participants most commonly noted that the BYOD system facilitated attention

maintenance during class. That is, students suggested that it kept them "on task" and supplied instantaneous feedback. Students noted that the use of BYOD technology encouraged their attendance in class, without the process of actually taking attendance (though this feature is also available on the program). Participants also noted that it provided the opportunity to express themselves in a way that otherwise would have been impossible given the class size. Participants suggested that the use of the system was particularly helpful in facilitating discussion during class time. It changed the dynamic of the course, as students seemed to feel as though they were part of the discussion, rather than being lectured at. In addition, the in-class features allowed students to respond to questions that were, at times, highly sensitive given the nature of the course, without feeling uncomfortable or singled. Participants reported that this anonymity facilitated more open and honest responses. One question asked how the BYOD system contributed to the overall classroom environment. Respondents suggested that it allowed for more openness, acceptance, and collaboration.

Assessing new educational technology requires consideration of technical and logistical aspects of the BYOD program. Participants were generally satisfied with the layout and technical performance of Tophat. The app was specifically mentioned because it showed the questions on cell phones rather than just on the presentation screen or a computer. One participant commented that adding a "push" notification to the app would be useful to alert students that questions had been posed or were due at a specific time. One challenge that was reported was the lag time in Internet accessibility in the classroom. This challenge, however, was associated with Internet availability, not the program itself. Another challenge that was noted was when using laptops as opposed to cellular devices, occasionally, there was insufficient time to start the laptop to respond to questions in real time. During class, it appears from participant responses that cellular devices work best.

Discussion feature: The discussion feature of the BYOD system (used to provide weekly homework assignments) elicited general responses that involve critical thinking and in-depth analysis. Participants reported that discussions facilitated a critical understanding of the material rather than passive engagement. There was general consensus that the discussion feature allowed for freedom of expression on specific topics where opinions, values, and attitudes were queried. Participants noted that they self-reflected on the material they were discussing. Two drawbacks were noted: First, participants noted that reminders about discussions being due would have been helpful (as they were assigned in class on Tuesday afternoon and due by the following Monday at midnight). Second, participants indicated that, early in the semester, they were unable to see their responses after they had been submitted. This has since been modified in the program but students noted that this was sometimes stress inducing, as they feared their responses had not been received.

Tournament feature: The tournament tool of the BYOD system allows students to compete against each other during timed questions. In this course, the tournament feature was used as a review prior to exams, outside of class time, with the winner being awarded bonus points on the exam. Participants were satisfied with this part of the program, reporting that it not only provided for a virtual study session, but that it was fun and engaging. It was noted that this was a good assessment of students' knowledge and retention from class. In addition, it was seen as a way to engage the course readings outside of class time. The drawback to this feature is that all students must be available to participate at a specific time. Some students had other engagements and could not participate in the actual tournament though they were subsequently able to review the questions.

Focus Groups
Two small focus groups took place, involving a total of 5 students (3 female). The students were enrolled in the course as an elective, which is common for this large course, and were in their third or fourth year of their undergraduate degrees, from the disciplines of psychology, nursing (2 students), biology, and political science.

Several themes emerged from conducting coding and thematic analysis on the data after it had been transcribed verbatim. These themes were organized into the categories of benefits and limitations of using the BYOD technology. The themes falling under the benefits of using the system are discussed below first, followed by limitations.

Major Theme – Engagement: One theme surrounding the benefits of using the BYOD system emerged from the data that was more prominent and significant than any other: *Engagement*. This theme was broken down into two sub-themes: (1) In-class engagement, and (2) Engagement in course material. In regard to the first, in-class engagement, participants indicated that using the BYOD system contributed to a collaborative learning environment and facilitated engagement in the classroom despite the large class size. One student said, *"It's just, it's really hard for*

400 people to all, you know, raise their hand and give their own opinion, so by giving like questions you feel like you're participating in the class instead of a number", while another said *"it kind of shaped the learning experience with everybody"*. They perceived that system encouraged attendance, and that the opportunity for in-class participation points encouraged engagement without the pressure of requiring a correct response, which they felt positively contributed to their understanding and remembering course material. In that respect, a participant said, *"...even if it's not graded, that helped you later on when you were graded, you were like, 'Oh hey, I remember doing that'"*.

The second part of the major theme of engagement was how students perceived that the BYOD system facilitated their engagement in the course material and content, beyond class time, and that it offered the opportunity for expanding on in-class discussion, and helped focus studying. In regard to the use of weekly discussion questions focused on course material, one participant said, *"I think I probably understood them better because [...] we had to take what we learned and we had to think about it to come up with a response [...] I think I was able to put my own spin on it and think about it to understand it more"*. Participants also noted the value of the BYOD system in supporting deeper understanding of content, demonstrated by saying *"it's not a question you can easily answer at the top of your head, like a yes or no, it's like oh well I have to go back and look at it, [...] it gives you a better understanding of what's actually going on and what a concept actually meant."* Students also valued the opportunity for reflecting on their own opinions and values using the BYOD system, with one saying, *"by expressing your opinion it helped you connect to the topic [...] so it's easier to memorize or grasp your understanding about the concept"*.

Other Themes - Benefits: Several other themes emerged as benefits of using the BYOD technology. Similar to the above-described online survey responses, participants noted that the BYOD system facilitated increased comfort with potentially sensitive material, despite the large class size, with one student stating, *"some questions are maybe a little awkward to actually talk about in class, and then you can just kind of send it in",* and another saying *"people got more comfortable with like actually talking about things, especially sexuality"*. Students also valued the ability to compare their in-class responses to others and see their classmates' perspectives, which contributed to reflection and critical thinking. Notably, one student said, *"it was interesting just to see different perspectives, what people thought in class, cause sometimes [...] like you have one opinion and you automatically assume that's everyone else's, [...] so it was good to see the different perspectives"*, and furthered that thought by saying *"[it] made me more critical about things..."* Students also commonly discussed their perspective that using the BYOD system was fun and enjoyable, *"you were excited and it made you think you weren't like pressured or anything."* Finally, participants noted the value of using their own device, and compared the BYOD technology to other systems they had used, such as 'clicker' systems, noting they preferred BYOD, with one simply stating, *"It was one less device you had to carry."*

Limitations of using BYOD technology: Students perceived far fewer limitations of the BYOD system than benefits. Of the minor limitations discussed, students specifically mentioned the tournament feature, which was used for optional review sessions, typically scheduled on the Sunday afternoon prior to exams on Tuesdays. Students found the tournaments offered an excellent opportunity for review, but did perceive them to be stressful and frustrating at times. The frustrations were due to slow connections in a fast-paced tournament, and some wished they could see the correct responses for a longer period following the tournament. *"I was super stressed out when I was doing them",* said one student. It is important to note, that since the time these students were enrolled in the course, the technology has improved to prevent the lagging that was happening, and the questions can now be opened for all students to review, regardless of their ability to participate during the scheduled tournament time. Students also noted that they found the system to be slightly complex at the beginning of the course: *"when we were first using it, I found it difficult to figure out [...] just as we were getting used to it."* Finally, students indicated that they sometimes forgot to respond to out of class questions (as the system exists independent of the university's current online system) and would like a reminders feature within the university's system. Aside from those, in regard to discussing limitations, students said, *"I don't find any drawbacks,"* while another said, *"I don't think so, it was really positive to have,"* indicating the overall value if using a BYOD system.

Quantitative Survey
The results of this survey were gathered online using Opinio. The survey is currently open and ongoing with the most recent semester of students. As such, these results are preliminary, subject to change, and will only be briefly summarized. After having the survey open for less than a week, we have had 45 students

with an average age of 20.9 take part (11% of the course). Eighty-four percent of respondents were female, though enrolment in the course typically includes significantly more female than male students. Seventy percent of respondents were in their third or fourth year of an undergraduate degree, 98% of which were enrolled as full time students. Respondents included students in Sciences, Arts, Nursing, Psychology, Health Promotion, Kinesiology, and other disciplines. As students typically take the course as an elective from a variety of disciplines, this array is common for this course. Ninety-three percent of respondents identified English as their first language, with 77% having been born in Canada, and 86% identifying as White or Caucasian.

As described above, the survey involved combining and modifying the Educational Practices Questionnaire, Simulated Design Scale, & Student Satisfaction and Self-Confidence in Learning instrument (National League for Nursing, 2006), into a 23-item scale-based survey. Questions were grouped into seven categories: (1) active learning, (2) diverse ways of learning, (3) expectations, objectives, and information, (4) support and satisfaction, (5) problem solving, (6) feedback, and (7) self-confidence in learning, with several positively-worded statements in each section, and all statements requiring a response of strongly disagree, disagree, undecided, agree, or strongly agree, on a 1 to 5 scale.

In regard to 'active learning', students responded to statements about the BYOD program's influence on engagement in the course and with professor and teaching assistants. In this section, an average of 66% of respondents indicated 'agree' or 'strongly agree'. In the 'diverse ways of learning' section, students responded to statements about how the program responded to ways of learning and assessing knowledge, and 78% indicated 'agree' or 'strongly agree'. In response to statements in the 'expectations, objectives, and information' section, regarding students' comprehension of the BYOD system, 84% responded with 'agree' or 'strongly agree'. In regard to statements describing support and satisfaction with the BYOD technology, 77% of respondents indicated 'agree' or 'strongly agree'. In considering statements regarding the BYOD's influence on problem solving abilities, 71% responded with 'agree' or 'strongly agree'. Concerning feedback in the BYOD system being timely and constructive, 55% of students indicated 'agree' or 'strongly agree'. Finally, in regard to the BYOD program contributing to student self-confidence in learning, 78% responded with 'agree' or 'strongly agree'.

Below are several figures that visually illustrate the distribution of responses in questions from several categories.

Figure 1: Student responses to the statement, "Using Tophat offered a variety of ways in which to learn the material", from the 'diverse ways of learning' category.
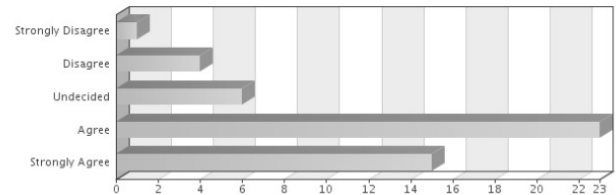

Figure 2: Student responses to the statement, "I know how to use Tophat to learn critical aspects of the course", from the 'expectations, objectives, and information' category.
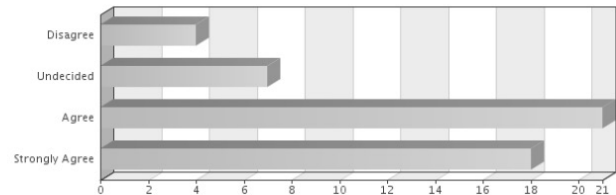

Figure 3: Student responses to the statement, "The teaching materials used in Tophat were motivating and helped me to learn", from the 'support and satisfaction' category.
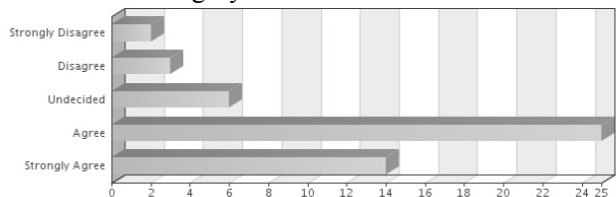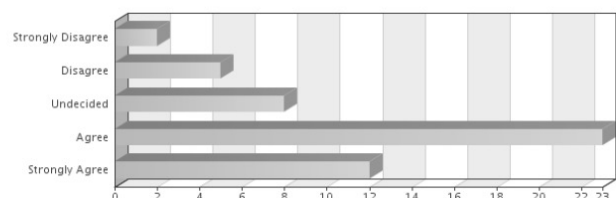

Figure 4: Student responses to the statement, "I am confident that I developed skills and obtained knowledge through using Tophat", from the 'self-confidence in learning' category.

In sum, the response to using the BYOD program appears to be largely positive, with the majority of students responding to the survey indicating the benefits of the technology in a variety of areas related to their learning. In particular, these results indicate that there is room for improvement in the areas of

feedback and active learning, while the areas of expectations and objectives, and some questions relating to self-confidence are particularly supportive of the benefits of using the BYOD system. As this research is ongoing and the results are preliminary, more specific and in-depth analysis will allow further understanding of each of these areas.

ONGOING RESEARCH

This paper presented the preliminary results of an exploratory mixed methods study to investigate the experience and impact of using BYOD technology (the Tophat program) in a large post-secondary education classroom, which included qualitative and quantitative data from two semesters. A third semester of research is currently underway, with a repetition (and refinement) of many of the measures presented in this paper, as well as additions. Derived from the findings presented in this paper, quantitative survey questions related specifically to the Tophat experience have been designed, and added to the Opinio survey to allow more specific exploration of that experience. Further a reliable and valid measure of critical thinking, the Cornell Critical Thinking Test, has been added, which is being used as a pre- and post-indicator of potential change in critical thinking skills in association with using BYOD technology.

CONCLUSIONS

The findings from this research suggest that the use of BYOD technology and specifically the Tophat program contribute positively to students' educational experiences. Specifically, an enriched classroom experience and depth of knowledge and understanding emerge as the most prominent positive contributions of this tool. Though some limitations are noted within, the overall student perception of the use and effectiveness of BYOD technology is strong and shows promise. These preliminary findings will be further expanded upon as more data is gathered and additional tools to measure effectiveness are implemented.

REFERENCES

[1] Van Dusen, G. C. **The Virtual Campus: Technology and Reform in Higher Education**, ERIC Digest, 2009.

[2] Wagner, N. L., Hassanein, K., & Head, M. M. "Who is Responsible for E-Learning Success in Higher Education? A Stakeholders' Analysis", **Educational Technology & Society**, Vol. 11, No. 3, 2008, pp. 26-36.

[3] Tremblay, E., "Educating the Mobile Generation– using personal cell phones as audience response systems in post-secondary science teaching", **Journal of Computers in Mathematics and Science Teaching**, Vol. 29, No. 2, 2010, pp. 217-227.

[4] Sandelowski, M., "Whatever happened to qualitative description?", **Research in Nursing & Health**, Vol. 23, 2000, pp 334-340.

[5] Miles, M. B. & Huberman, A. M., **Qualitative Data Analysis: An Expanded Sourcebook (2 ed)**, Thousand Oaks: SAGE Publications Inc, 1994.

[6] National League for Nursing, **Designing and implementing models for the innovative use of simulation to teach nursing care of ill adults and children: A national, multi-site, multi-method study,** New York: NLN, 2006.