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Evaluating student perceptions of a multi-platform classroom response system in undergraduate nursing

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ABSTRACT

Background: Classroom response systems (CRSs) support interactive learning in undergraduate nursing education. Simple "clicker" hardware has evolved into more sophisticated multi-platform software allowing multiple operating systems and devices including smartphones, tablets and laptops to enhance in-class, proximate student engagement. However, student perspectives of multi-platform mobile CRSs have not been assessed among undergraduate nursing students.

Objectives: To evaluate undergraduate nursing student perceptions of usability, engagement, and learning associated with Top Hat™ CRS software.

Methods: This descriptive study utilized a cross sectional survey of undergraduate Bachelor of Nursing Science (BNSc) students enrolled in a four-year (n = 160) and a two-year (n = 75) accelerated program. Descriptive statistics were used to evaluate learner perceptions of usability, engagement, and learning, measured using the Classroom Response System Perceptions (CRiSP) questionnaire. Thematic analysis was used to examine data from open-ended questions designed to capture qualitative feedback related to the perceived benefits, limitations and the technology's impact on learning.

Results: Students perceived the use of the CRS, TopHat™, as a positive influence on classroom learning. The mean CRiSP scores for all subscales [usability 16.51 (SD 2.7), engagement 40.97 (SD 7.2), learning 43.96 (SD 6.8)] correlated with "agree" or "strongly agree". There was no statistical difference among CRiSP scores between the two programs. Students reported that CRS in the classroom improved learning, enhanced formative assessment and increased participation. Perceived limitations include practical drawbacks such as redundant features, technical difficulties, limited access and cost. Moreover, some students felt that it did not add value to teaching as it was disruptive to classroom time.

Conclusions: This study addresses a gap in the nursing education literature and contributes to the growing body of scientific knowledge related to using technology in proximal classroom teaching. One multi-platform CRS, TopHat™, did enhance learning but important recommendations and limitations should be considered before implementing this technology.

1. Introduction

Institutions delivering post-secondary nursing programs are striving to deliver high quality education to large class sizes. On average in the United States, faculty-student ratios range from 1:100 to 1:500 and it is known that class size is inversely proportionate to student performance (Suchman et al., 2006). Many instructors motivated to capture their student's attention and enhance engagement in learning are challenged to do so by the current generation of students who are digital natives with high technology literacy (De Gagne, 2011; Lai and Hong, 2015). It is estimated that at any given lecture, the professor contributes 80% to in class discussions and only a small proportion of students actively engage, often repetitively, with them (Weaver and Qi, 2005). Disengaged students in large classes frequently sit in the periphery of a lecture theatre and passively withdraw from contributing while others may feel intimidated to openly express their opinions in fear of producing an incorrect answer and facing criticism and disapproval from their peers and/or instructor (Weaver and Qi, 2005; Atlantis and Cheema, 2015). This is problematic as some of these students are not actively engaging with course content; limiting their ability to comprehend content, develop essential critical thinking skills to be used in clinical practice and nurture faculty-student interactions.

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It is within this context that classroom response systems (CRSs) have grown in popularity to support interactive learning within large classes. CRSs strive to assist students to develop critical thinking competencies through cognitive processes such as application, synthesis, and evaluation (Cahnmann-Taylor and Siegesmund, 2017; Abrahamson, 2006). They also allow instructors to use instructional strategies to enhance learning and motivation such as immediate feedback, classroom monitoring, audience-paced instruction, peer instruction, equal participation, game-based learning and formative assessment (Center for Education Innovation, n.d.; Walsh and Sattes, 2016).

Formative assessment is an established process involving a range of assessment procedures conducted by the instructor during the learning process (Nicol and Macfarlane-Dick, 2006). The purpose of formative assessment is to provide a general idea of what the student knows and doesn't know in order to make responsive modifications to learning and teaching in real time. Formative evaluation is important in establishing frequent feedback between the instructor and the student, allowing for instructors to identify knowledge gaps and address them accordingly (Rowles and Brigham, 2005). Feedback and discussions resulting from the formative assessment allow learners to become acutely aware of their knowledge gaps and guide students to take action for their learning (Nicol and Macfarlane-Dick, 2006). Receiving formative feedback congruently in the learning process empowers learners to be self-regulated (Nicol and Macfarlane-Dick, 2006). Using this method, students can identify their own knowledge gaps, clarify misunderstandings, and review key concepts. Furthermore, feedback from students allows instructors to adjust their teaching approach in response to expressed knowledge gaps in real-time. This can be accomplished by initiating discussion to clarify misunderstanding, taking alternative approaches to explaining unclear concepts, and utilizing additional explanatory visuals.

CRS technology allows the instructor to pose questions and poll students' answers instantaneously during didactic lectures. This type of questioning approach involves more respondents than traditional methods such as posing verbal questions aloud to a large audience, which typically yields low participation rates. CRS technology has developed rapidly over the past two decades since its emergence into educational setting in the mid 1990s (Lane and Atlas, 1996). The colloquial, “clicker”, which is a handheld piece of hardware with keypad, was the first CRS to be widely adopted as it could collect learner responses to multiple-choice questions within large group presentations. Responses were then amassed and instantly displayed in a chart demonstrating the number of students who selected each response option (Abrahamson, 2006). In this rudimentary form, CRS technology was restricted to multiple choice response formats, not interoperable with other software and students had to purchase and transport a physical piece of hardware to learning environments. Today, CRSs have evolved to become more complex, multi-platform software offered by multiple vendors (e.g. TopHat™, UniDoodle™, Echo360™, OMBEA™, Poll Everywhere™, Via Response™, Turning Technologies™, Infuse Learning™, Socrative™, I Clickers™, Kahoot!™, Quiz Socket™) with significant advantages over earlier response systems.

Current multi-platform CRSs allow learners to access learning software through any device that uses the internet such as a mobile phone, tablet or laptop. They offer several advanced features such as attendance tracking with geolocation functions, real-time interactive discussion boards, video-based learning and multiple types of question and response features (i.e. multiple choice, open-ended questions, matching, sorting, click on target). These types of higher cognitive questions are known to assist in the development of complex thinking processes. When students are required to manipulate information to support a response, they demonstrate higher levels of achievement compared to lower cognitive questions which require verbatim recall or recognition of factual information (Redfield and Rousseau, 1981). Effective questioning also elicits and promotes Bloom's et al. (1956) six levels of cognitive processes (e.g. recalling, understanding, applying, analyzing, synthesizing and evaluating) and enhances critical thinking (Davoudi and Sadeghi, 2015). Furthermore, tracking in-person attendance can be beneficial for struggling students as there is abundant evidence suggesting a strong correlation between class attendance, academic performance, and study habits (Credé et al., 2010; Abrahamson, 2006).

De Gagne (2011) conducted a literature review on CRS technology about how clickers can best be used to promote learner engagement among undergraduate nursing students and to better classroom education. They identified three key characteristics of clicker use in nursing, medical, pharmacy, and paramedic education among fifteen empirical studies: interactivity and participation; satisfaction and learning outcomes; and formative assessment and contingent teaching. In another study, Revell and McCurry (2010) assigned their nursing students a responder keypad and incorporated a variety of questions (e.g. fill-in-the-blank, chart exhibition) in their PowerPoint presentations. Their findings suggest that the use of a response system was received well by the students and there was evidence of enhanced critical thinking and knowledge acquisition. A similar study conducted by Porter and Tousman (2010) evaluated the perceived effectiveness of personal CRS technology in enhancing student learning in small and large undergraduate classrooms (n = 149). They incorporated a variety of question types into didactic PowerPoint presentations and found that the use of CRS technology was effective for educating millennial learners in small and large classrooms.

Successful implementation of technology in the classroom setting is a complex process involving a variety of factors. Age is commonly identified as an influential factor in predicting technology use as young adults frequently enter postsecondary education with a wealth of technology experience compared to older adults who are less inclined to use new technology (Czaja et al., 2006; Rideout et al., 2010). In a recent survey, Lai and Hong (2015) found there was no difference in technology use patterns when comparing three age groups of students (< 20 years, 20–30 years, and > 30 years). These generational differences may be important to consider when evaluating perceptions of CRS technology among nursing students; especially if students are entering nursing after a previous undergraduate degree.

Overall, there is limited research exploring student's perspective of CRS technology in classroom settings. Moreover, there is a need to evaluate undergraduate nursing student perspectives of newer multi-platform mobile CRSs such as, Top Hat™ to ensure they are assessed in unbiased manner. This study aimed to address the research question, what are undergraduate nursing students' perceptions of Top Hat™ software used in classroom settings?

2. Methods

A qualitative descriptive approach was selected for this study to provide a rich but straight forward description of the experience under study (Neergaard et al., 2009). As described by Neergaard et al. (2009), this approach is best suited for mixed method research to gain knowledge of the perception of a particular experience. A qualitative descriptive approach focuses on low-inference description, characterized by staying closer to the data and to the overall surface meaning of the words (Colorafi and Evans, 2016).

A cross sectional survey was distributed to undergraduate nursing students (N = 236 students) at Queen's University located in Kingston, Ontario over the 2016/2017 academic year. Students were enrolled in four-year (n = 160) and two-year (n = 75) accelerated Bachelor of Nursing Science (BNSc) tracks across four different courses (e.g. psychiatric mental health nursing, common health challenges and implications for nursing care, community health nursing and principles of nursing research) that utilized Top Hat™, a CRS technology over a 12-week period. Students in the accelerated track transferred from other academic disciplines and must have completed at least 10 full university courses previously. Participants were in various years of study and included second ($n = 45$), third ($n = 58$), and fourth ($n = 57$) year students in the 4-year track program and first ($n = 36$) and second ($n = 39$) year students in the accelerated 2-year track program. Participants were eligible to participate if they were: 18 years of age or older and able to read and speak English.

To ensure confidentiality and reduce bias in study results, potential participants were approached by a third-party research assistant (i.e. who was not the course instructor or teaching assistant) to solicit involvement at the end of the 12-week term. Instructors were asked to leave the lecture hall while participants received a verbal and written explanation of the study, which included information about the risks and benefits of participating and their right to withdraw from the study at any time. Students were told that their choice to participate would not affect their overall mark. Eligible and consenting participants where then asked to complete an anonymous paper survey.

2.1. Outcome measures

Learner perceptions were measured using the *Classroom Response System Perceptions (CRiSP) Questionnaire* which is a quantitative measure of student perceptions of CRS technology (Richardson et al., 2015). It was validated through focus groups, one-on-one interviews and a factor analysis of survey responses. Three factors (i.e. usability, impact on engagement, impact on learning) were identified across 26 items. These items addressed the following concepts: recommended use, overall value, motivation, interaction, instant feedback, peer awareness, enhanced understanding of concepts, instructor responses to results, enhanced learning, control over learning, thinking deeply, correct but not understand, confidence, mostly used, participation, attention, concentration, attendance, ease of use, expectations, technology problems, wasted time, enjoyment and anonymity (Richardson et al., 2015). As interpretation of CRiSP subscale scores is not available in the published literature, a face value interpretation was created by relating raw scores for each subscale (i.e. usability 0–20, engagement 0–55, learning 0–60) to a five-point ordinal scale (e.g. strongly disagree, disagree, neutral, agree, strongly agree). See Fig. 1 for subscale score interpretation.

Demographic data and open-ended questions were also posed to learners to solicit narrative feedback about perceived benefits and limitations of using TopHat™ software in the classroom setting. Participants were asked to identify which track of study they were enrolled in (4-year vs 2-year accelerated), their sex, age, and previous use of CRS or TopHat™ in other courses. They were then asked to elaborate on features of TopHat™ that were the most and least useful, and their preferences for CRS technology. Additional qualitative data was retrieved from University Survey of Student Assessment of Teaching (USATs) for instructors. This routinely administered survey utilizes student responses to evaluate courses and instructors at the end of each 12-week term. It also includes space for comments, which students are encouraged to complete to give instructors specific feedback. Only comments regarding the use of the CRS, Top Hat™, were analyzed.

Subscale	Ranges	Interpretation
Usability Score	0.1-4.0	Strongly Disagree
	4.1-8.0	Disagree
	8.1-12.0	Neutral
	12.1-16.0	Agree
	16.1-20.0	Strongly Agree
Engagement Score	0.1-11.0	Strongly Disagree
	11.1-22.0	Disagree
	22.1-33.0	Neutral
	33.1-44.0	Agree
	44.1-55.0	Strongly Agree
Learning Score	0.1-12.0	Strongly Disagree
	12.1-24.0	Disagree
	24.1-36.0	Neutral
	36.1-48.0	Agree
	48.1-60.0	Strongly Agree

Fig. 1. Subscale score interpretation.

2.2. Data analysis

Demographic variables and responses to the *Classroom Response System Perceptions (CRiSP) Questionnaire* were analyzed using descriptive statistics, standard deviations (SD) and proportions at a significance level of $p \leq 0.05$. Thematic analysis using a semantic approach was used to analyze qualitative data (Braun and Clarke, 2006). Statements were ordered and organized by reading and re-reading the material, relevant ideas were selected, coded and grouped accordingly to their similarity before being organized into themes and sub-themes. All text provided by participants was reviewed multiple times before initial codes were generated to characterize pertinent findings. Using a systematic method across the data set, codes were then grouped into a thematic map, which was used to identify the hierarchical relationship between themes (Braun and Clarke, 2006). After repeatedly reading the text, the themes were named and assigned definitions. The significance of identified themes was then discussed among the principle researchers in relation to broader concepts to assist in refining and providing further insight (Braun and Clarke, 2006). Lastly, a third-party researcher with expertise in this area was invited to critically evaluate the identified themes and offer their insights into the interpretation of them.

3. Results

3.1. Demographic variables

See Table 1 for a description of participants. When assessing demographic differences between the two tracks of study (four-year vs. two-year), there were statistically significance differences ($p < 0.05$) in age (21 vs. 24 years) and in previous use of other CRS software (0.9% vs. 8%).

3.2. Classroom Response System Perceptions (CRiSP) Questionnaire

The mean scores for all subscales (usability 16.5 (SD 2.7), engagement 41.0 (SD 7.2), learning 44.0 (SD 6.8) correlated with “agree” or “strongly agree”, suggesting students perceived the use of the CRS, TopHat™, as a positive influence on classroom learning. There were no significant differences ($p < 0.05$) noted in total CRiSP score or subscale scores between the two tracks of study. See Table 2 for analysis of CRiSP total and subscale scores.

3.3. Qualitative responses

Several prominent themes emerged in both the perceived benefits and challenges of using TopHat™ technology in the classroom. Students discussed three themes when describing the benefits of the CRS. See Table 3 for description of themes and sub themes with supporting quotes.

The first theme was improved learning supported by the following subthemes: validated knowledge and reinforced learning through identification of key concepts, clarified misunderstanding and assisted in identifying knowledge gaps and improved critical thinking through

Table 1
Demographic characteristics.

Demographic variables	Mean (SD)			Range	*t*–Test	sig
	N = 179*		N = 236			
	4 year track (*N* = 104)	AST track (N = 75)	Total (N = 236)			
Age (years)						
Mean (SD)	21.02 (1.1)	24.22 (2.5)	22.43 (2.5)	20–25 (4 Year) 21–36 (AST)	−11.42	< 0.001

Demographic variables	Frequency (%)				X^2	sig
	4 year track	AST track	Total (N = 179[a])	Total (N = 236)		
Sex						
Female	96	65	161	215	1.53	0.216
Male	8	10	18	21		
Used TOP HAT in other courses	44 (42.3%)	42 (56.0%)	86 (48.0%)	141 (59.7%)	3.27	0.070
Used other CRS in other courses	1 (0.9%)	6 (8.0%)	7 (3.9%)	35 (14.8%)	5.74	0.017

[a] 57 missing cases – Respondents did not indicate which track they were in.

knowledge application. The second was enhanced formative assessment espoused by the following subthemes: increased peer awareness and initiated discussions and instant feedback. The final theme was increased classroom participation supported by the subthemes: increased participation resulting from enhanced anonymity, maintained motivation, stimulated learning and increased attention and confidence. Anticipating classroom discussions, students indicated they were also motivated to keep up-to-date with prerequisite readings and lecture material. Students become engaged in responding to questions, externalized their rationale, engaged in the process of reasoning, and become active participants in learning.

Conversely, students discussed two themes related to perceived limitations of TopHat™ including practical drawbacks noting redundant features, technical difficulties, limited access and cost. Paid subscription (CAD$26 for one term, CAD$38 for one year, CAD$75 for four-years) to TopHat™ was mandatory for all students attending the surveyed classes. TopHat™ is reliant on devices with telecommunication abilities (i.e. wifi); therefore, many of the practical drawbacks were associated with connectivity in learning spaces. Students also reported that that there were instances where TopHat™ did not add value to teaching as it was disruptive to classroom time, was an inaccurate reflection of learner's understanding and inappropriate questions were used. In some instances, the questions displayed using the CRS technology did not provide insight to the learner's knowledge. During these instances, students found that they were required to guess the correct answer, copied others' answers or looked up answers on the internet instead of thinking critically. Students also expressed that CRS technology took time away from the context of content being taught and encouraged student to be more focused on their technological devices.

4. Discussion

This study demonstrates that undergraduate nursing students perceive that using the CRS software, TopHat™, confers overall benefits in usability, engagement, and learning in classroom settings. There were differences noted between the two tracks of nursing (4-year vs 2-year) in relation to previous experience with CRS technology, this can be attributed to the accelerated students having exposure in previous undergraduate experience. Differences between tracks did not persist when evaluating CRiSP subscales and total score. The qualitative data suggests that respondents perceived many benefits and some limitations. Our findings inform the following recommendations for future CRS use in proximal undergraduate teaching.

4.1. Effective instructional design should be coupled with CRS technology

Several students noted that the effectiveness of the educator and their instructional design skills directly influenced the successful implementation of the CRS, TopHat™. This is supported by previous research that describes one element of effective instructional design as including an organized question cycle. This is a process involving posing a question to the students, allowing time to submit their answers, displaying the histogram, and promoting discussion based on the results (Beatty, 2004). Moreover, questions should directly correspond to the key concepts discussed by the instructor, which assists in the prediction of future exam questions and topics. Feedback received from the organized question cycle should inform the instructor's teaching, especially when the majority of the students answer a question incorrectly. When questions posed did not stimulate impactful discussions, students expressed dissatisfaction with CRS technology.

Another important element of instructional design is how

Table 2
Analysis of usability, engagement, learning and CRiSP scores.

	Mean (SD)			Range	*t*–Test	Sig
	4 year track (N = 104)	AST track (N = 75)	Total (N = 236)			
Usability Score (Out of 20)	16.61 (2.2)	15.97 (3.2)	16.51 (2.7)	7–20	1.534	0.127
Engagement Score (Out of 55)	39.15 (7.2)	40.41 (7.0)	40.97 (7.2)	11–55	−1.134	0.259
Learning Score (Out of 60)	42.00 (6.7)	43.51 (6.1)	43.96 (6.8)	12–59	−1.517	0.131
Total CRiSP Score (Out of 135)	98.37 (14.3)	100.29 (14.1)	101.88 (14.6)	39–134	−0.854	0.394

Table 3
Perceived benefits and limitations with sub themes and supporting quotes.

	Themes	Subthemes	Supporting quotes
Perceived Benefits	Improved learning	Validated knowledge and reinforced learning through identification of key concepts	“It made me think about what I was learning and helped me prepare for exams”
			“Questions asked corresponded with key points. Reinforced importance of these points”
			“I was able to gauge my knowledge through helpful practice questions”
			“Starting the lecture with Tophat™ questions was a good way to introduce a topic and see how much I knew about it already”
		Clarified misunderstanding and assisted in identifying knowledge gaps	“The professor would go over and explain why certain answers were right or wrong”
			“I enjoyed […] hav[ing] the professor clarifying [the] confusion”
			“It was the practice questions which gave me the chance to see what I actually have learned and what I understand compared to what I need to study more of”
			“It allowed profs to see where people were choosing and analyze why the answers were wrong or correct”
		Improved critical thinking through knowledge application	“Answering questions that involved writing a short answer helped me think about course material and apply my learning”
			“I liked how I could see what I actually knew from the lectures/courses and force me to think critically”
	Formative assessment	Increased peer awareness and initiated discussions	“I liked how I was able to see what other people were thinking as well”
			“Discussion questions in which we could see classmates' responses in real time. Increased awareness and discussion among students”
			“I liked how it shows the ratio of students per answer”
		Instant feedback	“Instant feedback let me check my responses”
		Maintained motivation	“The attendance feature also motivated me to come to class”
	Increased participation	Stimulated learning and increased attention	“The questions really encouraged audience/student participation”
			“The material was presented clearly and the use of TopHat™ made it easy to engage in the lecture (ie. questions, attendance)”
			“Presenting the class through TopHat™ stimulated my learning as I paid attention more. It was interactive and fun and made me come to class”
		Enhanced anonymity	“Anonymous ensured everyone felt comfortable participating”
			“Questions were anonymous, allowed me to fairly participate”
		Increased confidence	“Tophat™ increased my participation in class and made me more confident to participate”
			“I was able to voice my opinion and be more involved in class discussions. The changes from lecture helped me focus and keep me interested during long lectures”
		Redundant functions	“You could not take notes on the slides presented in TopHat™ and had to use the PowerPoint to take any additional notes”
			“I find it difficult to navigate back to previous lectures, I end up just downloading them from PowerPoint as well”
			“If trying to make notes on slides, they would automatically change when the instructor switched it. Had to keep clicking back to get to the original page”
Perceived limitations	Practical drawbacks	Technical difficulties	“Hard to connect in class frequently. I couldn't answer one question and would lose marks because of connection issues”
			“Frustrated to lose marks for an internet problem”
			“Some professors had technical difficulties with it- it wasn't a smooth transition from PowerPoint presentation to TopHat”
			“I found that the instructors' lack of knowledge in how to use TopHat™ just took up class time and distracted me from the material. It might be helpful to provide training to all instructors who choose to use TopHat™ to avoid these distractions”
			“When the instructors don't know how to use it consistently and effectively”
		Limited access	“We couldn't see the correct answer after the lecture or go back and look at the question”

(*continued on next page*)

Table 3 (*continued*)

Themes	Subthemes	Supporting quotes
		"We couldn't see the correct answers after class was over to go back and review"
	Cost	"I should not be paying for my mark"
		"It is a cost inconvenience for students as I did not find it to significantly improve my learning experience"
	Disruptive to classroom time (ie. Too many questions)	"It was interactive but sometimes I felt it took too much time away from the context being taught"
Did not add value to teaching	Inaccurate reflection of understanding	"You could look up the answers online. Once it was done there was no follow up of the material"
		"I do not think that the correctness of our responses should contribute to our grade. It is not an accurate evaluation of our understanding"
	Inappropriate questions and use for grading	"When it was used for really insignificant and tough questions that you knew you were going to get wrong (ex a random fact from the readings"
		"If questions were too obvious or too hard. I found it more helpful if I could make an educated answer in response to course material"
		"A lot of the questions were just guessing random numbers and didn't help with understanding the material. It was a guessing game more than a critical thinking game. Most questions did not reflect what the test questions would be".
		"Only specific questions can be asked with TopHat™ (ie. critical thinking isn't addressed as much)

assessment is used. Some instructors used the CRS technology as a grading tool and students felt this limited their learning. One student commented, "*the fact that it [CRS technology] was used for marks made it more stressful and penalized students for being honest about areas that you don't understand*". While another expressed that "*lecture is a time for learning, [and] not a time for evaluating*". Finally, students commented that there were inconsistencies in technological literacy between instructors. Some suggested that providing technological assistance to instructors may improve the learners' overall experience with CRS technology and improve the quality of questions posed.

4.2. Anonymity

What contributed greatly to increased participation in the classroom is the anonymity function of the CRS technology. Particularly in large group learning, students often feel embarrassed and/or intimidated to participate, especially if there is a chance that they may answer incorrectly. Students fear that they will face criticism and ridicule from their peers and instructors by answering incorrectly or voicing an unpopular opinion (Weaver and Qi, 2005; De Gagne, 2011; DeBourgh, 2008). Cultivating a safe learning environment, one which encourages students to learn from their mistakes will promote motivation and autonomy (Rowles and Brigham, 2005). One student commented, "*it [CRS technology] made me more comfortable and motivated to participate, being shy I don't put my hand up in class*".

The anonymity function allows for a passive learner to become an active one and this is supported in the literature as a key advantage to CRS technology (De Gagne, 2011). By reducing the fear associated with participating, anonymous participation provides opportunities for students to answer freely without the fear; therefore, encouraging students to become more engaged and maximize their learning in classroom settings. Moreover, students can evaluate their own level of preparedness when instructors incorporate informal, anonymous assessments throughout class time. This fosters communication to clarify misunderstanding and assist students to prepare for formal evaluations.

4.3. Developing student accountability

Several instructors decided to provide marks for attendance, which they believed developed student accountability. Learners commented that the attendance feature motivated them to come to class and be prepared for upcoming lecture content. A unique attendance code was given each lecture and students were expected to enter it into the software. Instructors can use this valuable information to identify disengaged students early in the term and initiate conversations about how to be successful in the course.

4.4. Addressing the burden of cost

Many students discussed the technology's associated cost. Learners felt the cost greatly outweighed the benefits and commented that the CRS software fee was unnecessary. It was frequently suggested that there were similar and less costly options that could achieve the same outcome. For example, several respondents were simultaneously participating in a course with approximately 50 students and the instructor provided clickers to engage the audience.

In the future, educational institutions should advance their own software, such as Qlicker™, or obtain an institutional license for a preferred vendor. This would allow free access to all students, regardless of their discipline or degree program (Martin, 2018; Qlicker, 2018). Currently, CRS software is selected at the instructor's discretion and based on the nature of the course. This is problematic as students may be asked to purchase several CRS software packages or platforms throughout their degree program, further contributing to the burden of cost.

5. Limitations

The study has several limitations. First, the evaluation of CRS is confined strictly to TopHat™ and to undergraduate nursing students at one institution. Future comparison of a variety of CRS technologies among different student populations could provide further insight. Second, this survey was cross-sectional and describes students' perceptions at one point in time. Lastly, instructor feedback was not a component in this study. Identifying barriers and perceptions from the instructor's viewpoint may provide a more holistic view of CRS technology in classroom settings. Moreover, there may have been variability among the instructors' ability to use CRS technology and these factors could have impacted the study's results.

6. Conclusion

Undergraduate nursing students perceived multi-platform mobile CRS technology as useable, engaging and as beneficial to learning. Many students reported that CRS in the classroom improved learning, enhanced formative assessment and increased participation. Perceived limitations were also noted and included practical drawbacks such as redundant features, technical difficulties, limited access and cost. CRS technology offers unique opportunities to enhance classroom interactivity and has proven to be useful for students to learn effectively. Moving forward, addressing the highlighted recommendations and barriers will assist in the wider integration of CRS technology in higher educational institutions. Instructors should consider a series of factors when deciding whether to adopt a CRS technology in their classroom. These include the intended audience, the learning content, and technological competence of the instructor. As CRS technology continues evolve, it is paramount that instructors meet students where they are in a technology rich world and continue to be receptive to their feedback.

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