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Using live interactive polling to enable hands-on learning for both face-to-face and online students within hybrid-delivered courses.

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Abstract

Tertiary institutions are increasingly providing hybrid delivery options to students, requiring course coordinators to migrate formerly face-to-face curricula into frameworks that suit online teaching. However, there is a risk that the implementation of hands-on, engaging activities will decrease during hybrid sessions due to staff uncertainty of their effectiveness across the varied cohorts. This presents a need to identify engaging modes of instruction that can remain equally engaging for learning regardless of the students' enrolled mode of delivery. Interactive polling has the potential to be used within a class in real-time and allow both face-to-face and online students to take part in an in-class activity at the same time. This study aimed to compare the effects of interactive polling within either a face-to-face or online delivery format. One-hundred and seventy-four participants studying first-year health science and medicine completed a live interactive poll using the Kahoot! platform in either a face-to-face (*n*=72) or online (*n*=102) hybrid-delivered subject. Experiences and perceptions were provided as written responses and a Likert scale survey. Participant responses were positive, with three themes emerging, including interactive polling being enjoyable, engaging, and valuable for learning. Across cohorts, participants rated interactive polling highly, and perceived that it offered an effective learning and revision tool. This study found that interactive polling using Kahoot! maintains its suitability as a method of instruction across both face-to-face and online learner cohorts. The finding that it remains equally effective across both delivery modes provides evidence-based support for its use in hybrid or blended subject offerings.

Practitioner Notes

1. Many traditionally face-to-face teaching-focussed universities have recently migrated to a hybrid provision of educational material.
2. It is unclear which methods used to promote student engagement and interactivity in face-to-face sessions would translate well to delivery in an entirely or partially online course.
3. Interactive polling is well-suited for transition between face-to-face or online, with the benefits and learner perceptions retained regardless of the mode of delivery.
4. This study provides evidence to support educators wishing to embed interactive polling within either face-to-face, online, or hybrid lessons.

Keywords

Gamification, Kahoot, Formative assessment, Medical students, Engagement, Blended Learning

Introduction

Hands-on learning is an important component of the student learning experience (Jonassen, 1994). As the tertiary educational landscape continues to migrate from a focus on face-to-face delivery to an online or hybrid learning environment, educators are challenged to find teaching tools and interventions that provide equally engaging learning opportunities for all enrolled students. In hybrid or blended delivered classes, where course delivery combines face-to-face instruction with online learning, there is the risk that online students may not have the same opportunities for collaboration, competition, and peer learning as those studying on-campus (Dedeilia et al., 2020; Ishmuhametov & Kuzmenko, 2021). Live interactive polling may present opportunities for both online and face-to-face students to compete and collaborate in real-time during a presented session. The additional level of enjoyment which can arise from enhanced interactions between all students in a hybrid or online class may increase engagement and facilitate an enhanced learning experience overall. However, research into this potential is limited, with a recent review identifying the paucity of literature on whether live interactive polling is suitable for the provision of remote, or online learning, and highlighting this as a particular area of need (Donkin & Rasmussen, 2021).

Establishing a teaching presence through online modalities can be challenging as a physical presence in the classroom is not possible. Students are isolated from their peers and educators cannot engage and interact with them as individuals in many cases. There are pedagogical advantages to face-to-face teaching, such as real-time interpretation of learner engagement and understanding, measurement of student contribution, and peer learning (Kemp & Grieve, 2014). Live online learning can threaten some of these benefits, as students are isolated in a passive learning environment. Currently, there are a range of evidence-based approaches for online teaching, such as live sessions, flipped classrooms, or lecture capture (Hew & Lo, 2018). However, for the educator, constructing effective teaching practices across online modalities is vital when attempting to provide an equal learning experience to those studying on-campus and online (Seymour-Walsh et al., 2020). Fortunately, technology-enhanced learning can facilitate this need, and throughout the COVID-19 pandemic, where face-to-face courses saw a rapid shift to online delivery, educators incorporated a wide range of technologies to continue effective course delivery (Mian & Khan, 2020). In many cases, universities have adapted the structure and content of courses to enable student engagement within a virtual environment (Moro et al., 2021; Rad et al., 2021).

In a health sciences and medicine program, the sheer volume of information required to comprehend, and the expectation that students can apply this knowledge to real-world environments, means that tools that can assist and enhance learning may be of great benefit and support. The implementation of technology-enhanced learning can be one intervention that may enhance engagement and motivation when learning (Ismail et al., 2019; Kuehn, 2018). Activities prepared for delivery through online modalities enables learners and educators to work together on key learning resources and increases engagement, potentially promoting a learner-centred approach to learning, rather than the traditional one-sided lecturer-centred approach to teaching (Salmon, 2013). The fact that these technologies can be used collaboratively and at the same time as face-to-face attendees may bridge the gap between students in a hybrid class (Birt et al., 2018).

Gamification is one strategy that has received increasing attention in the online learning environment (Nieto-Escamez & Roldán-Tapia, 2021). The purpose of gamification is to implement game elements in non-entertainment contexts to promote learning, and gamification of learning has shown positive effects on cognitive, motivational, and behavioural learning (Sailer & Homner, 2020). Interactive polling through mobile internet-connected devices allows hands-on engagement with

live course content from anywhere in the world. One popular interactive polling platform, Kahoot!, is a gamification learning tool combining a variety of game elements including a competitive scoring system, leaderboard, 'ticking clock', and countdown music, while assisting students to test their knowledge. Kahoot! is available (free in some cases) for teachers and students on the internet via a web browser or by downloading the Kahoot! application and has the option to avoid the requirement for a login or formal authentication of users. Educators implementing interactive polling in their content delivery can assess knowledge gain in real-time, whereby students can be tested during a lesson, which provides the educator with immediate feedback on student performance (Neureiter et al., 2020). Kahoot! interactive polling is an innovative formative assessment tool that can enhance motivation, reflection, and feedback, and is recommended for health profession educators to incorporate in their face-to-face teaching (Ismail et al., 2019). However, these positive outcomes are limited to face-to-face settings, and it is unknown whether enhanced participation, motivation, and enjoyment are transferrable to online delivery of the activity. This is an area of particular interest as students attending classes remotely may be socially isolated and unable to collaborate with their peers (Asanov et al., 2021; Cockerham et al., 2021). The feeling of isolation that students may be overcome by in the online environment is particularly challenging for educators to overcome (Palloff & Pratt, 1999). When students feel connected to the course, as well as their educator and peers, this increases health and wellbeing (Lyons et al., 2020), academic success (Wilson, 2018), and graduate outcomes (Bridgstock et al., 2019). As such, finding methods to effectively integrate classroom activities in real-time with students face-to-face and online would be of great benefit to the learner.

Theoretical rationale

Firstly, this research project is structured around the Dewey (1986) theory of constructivism and hands-on learning, with its focus on the integration of real-world and classroom activities. As interactions take place between the learner and their environment, students become more engaged in the overall educational experience (Jonassen, 1994; Prince, 2004). As such, embedding interactive tools within sessions has the potential to enhance learning, student enjoyment in the class, and knowledge retention (Michael, 2006). However, as an increasing number of university courses migrate to a hybrid delivery format, the provision of interactive experiences becomes challenging, as an educator has to manage face-to-face students in front of them, as well as students viewing the session online. Although incorporating aspects of gamification into a class may present one way to achieve enhanced interactivity, it is vital for educators to take a thoughtful approach when integrating it into course content to ensure it aligns with learning goals, as well as considers the types of learners (Rutledge et al., 2018). This study was guided by the research question: 'Is the student experience from interactive polling transferrable between a face-to-face and online cohort?'. Kahoot! was chosen as the software to provide interactive polling in this study, as it offers a popular, internationally available, and gamified platform. The outcome will be to assess interactive polling as a pedagogical option within a hybrid course that might equally engage both face-to-face and online students during a live session.

Materials and methods

Participants

All students enrolled in a first-year medicine, biomedical science, or health science subject at an Australian university were eligible to participate in the present study. The study was advertised at the beginning and again at the end of the lecture time prior to the dissemination of the study survey. One hundred and seventy-four (174) first-year students from the Faculty of Health Sciences and Medicine volunteered to participate. The participants were currently enrolled in either a face-to-face

(n = 72) or online (n = 102) provision of their subject, which formed the two study groups. Face-to-face delivery was classified as students attending all classes on-campus, where the educator was present. Online delivery was students attending their classes online via computers using the platform Blackboard Collaborate (blackboard.com, Washington, D.C., USA). All recruited participants completed the study, and no data was withdrawn from the final analysis.

Study design

Participants attended a one-hour lecture, either face-to-face or online, as part of their Health Sciences and Medicine course. In the final 15 minutes of their lesson, participants completed a 10-item Kahoot! (kahoot.com, Oslo, Norway) interactive poll based on the session content. All sessions followed the same study protocol, including information provided to participants and the time at which the interactive poll and study survey was administered. The total study time lasted approximately 15 minutes. Participants completed a 10-question multiple-choice poll, with 20 seconds to answer each question. The time limit of 20 seconds per question was chosen as appropriate for the single-word answer options. All participants were able to answer the question within this timeframe, and in some cases, all had finished early and the poll automatically moved to the next question without further waiting. Martín-Sómer et al. (2021) reported the average time taken to answer multiple-choice questions was 15 seconds, meaning that a 20 second time limit would ensure that there was likely ample opportunity to read and answer each question. The question was first displayed on the main projected screen for five seconds before the answer options became visible, with participants required to select the correct answer represented in coloured boxes on their working devices (e.g., smartphone, tablet, or laptop) (Figure 1). Answers were displayed at the end of each question time, along with the frequency of responses to all answer options. At this time, an explanation was delivered verbally by the subject convenor to provide feedback and justify the correct answer.

Development and validation of the survey

A formal process was undertaken to develop and validate the administered survey questions. Initially, an expert committee of six academics with experience teaching first-year students was established to evaluate the face value of the survey and determine the content validity of the questions. This committee assessed each survey item on the relevance, clarity, format, simplicity, comprehensibility, and grammatical construction. The face validity of the survey questions was determined by the quantitative and qualitative methods. During this process, a group of 37 randomly selected participants underwent a pilot study, responding to nine Likert scale questions and three open-ended questions based on Kalleny (2020) and Tan et al. (2018). Of the nine original Likert scale questions, five were removed due to ambiguity or participants finding irrelevance. Three open-ended questions provided enough written feedback to reach the point of saturation. The internal validity of these survey questions was assessed for reliability using a Chronbach's alpha in SPSS v26 (www.ibm.com, Chicago, IL, USA). The Cronbach's alpha was 0.90, demonstrating an excellent internal reliability (Gliem & Gliem, 2003). No participants had any queries or questions regarding the survey questions after it had commenced.

Data acquisition

Prior to the study's commencement, participants were given a written explanatory statement and provided informed consent. Due to the nature of the student's enrolment, it was not possible to blind participants to which group they were in after allocation. Immediately after the lesson's conclusion, students were provided with a link and invited to fill out an online-based survey on Qualtrics

(Qualtrics.com, Provo, Utah, USA) to report their experiences. Quantitative data was collected through a five-point Likert scale questionnaire which included four statements related to perceptions and experiences of using interactive polling. The Likert scale statements included: "I enjoyed using Kahoot"; "The Kahoot! provided useful information that helped me reinforce what I learned in class"; "The Kahoot! platform was a good learning tool"; and "I was more confident in my knowledge after doing the Kahoot!". Written responses were also collected from participants immediately following the Likert scale questionnaire using the same Qualtrics survey link. Participants were provided with three open-ended questions to provide written responses based on their experiences and perceptions from using the interactive polling platform in both the face-to-face and online cohorts. The three open-ended questions were: "Would you like to use Kahoot! more in the future?"; "What aspects of using Kahoot! in class did you particularly like?"; and a "Further comments" box that allowed the provision of further comments. Ethics was approved by the University's Human Ethics Research Committee.

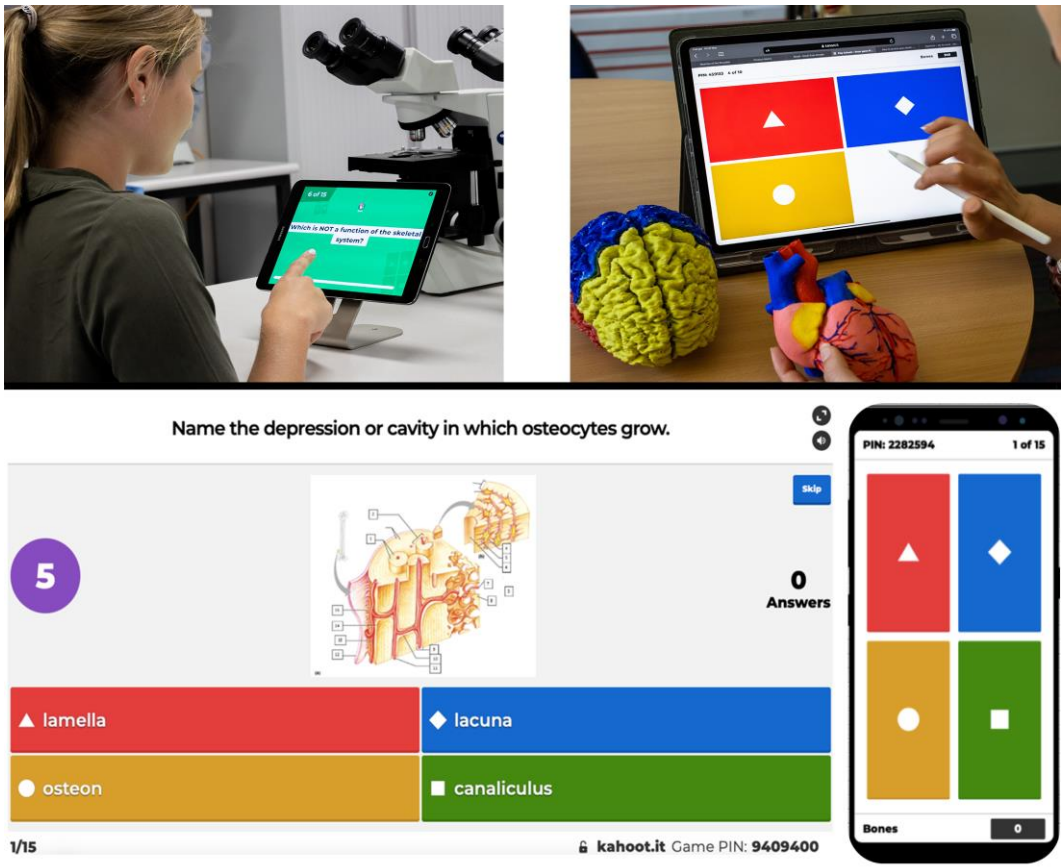

Figure 1:

Display of the Kahoot! interactive poll interface. The question is first visible on the main screen for five seconds (top left), before the answer options appear (bottom left). Students interact through their mobile devices or laptop computers to answer the question represented in coloured boxes on their screen (top and bottom right).

Data analysis

Researchers were blinded to which intervention related to which set of responses and did not become aware of this until after analysis was complete. Blinding of the outcome assessment was completed using Qualtrics XM, and anonymised data were then exported to a spreadsheet to analyse the results. Participant perceptions of the learning tool were rated using a five-point Likert scale (*1 = strongly disagree to 5 = strongly agree*), where higher scores indicated a positive perception about the learning mode. Results were entered into the statistical analysis program Prism v8 (GraphPad Software, San Diego, California, USA). An unpaired two-tailed Student's *t*-test, where $p < 0.05$ was considered statistically significant, was used to evaluate participant perceptions of using the interactive polling tool between the face-to-face and online cohorts. The Braun and Clarke (2006) six-phase qualitative analysis framework was applied to identify emerging themes from participant's written responses. The recommended stages for thematic inductive content analysis were as follows: 1) data familiarisation; 2) generating initial codes; 3) searching for themes; 4) reviewing themes; 5) defining themes; and 6) written analysis. Thematic analysis was completed manually, as per this framework, independently by two authors (CP & CM). This process was followed by a meeting to settle and discuss any disputes appearing. In all cases, disagreements were minor (with high interrater reliability, Coehn's Kappa coefficient = 0.8), and referral to an external academic was not required.

Results

Thematic analysis

Several emergent themes were identified in relation to student perceptions and experiences using the interactive polling tool face-to-face or online. The theoretical framework for qualitative analysis was followed, where numerous codes were identified, and overarching themes built based on the initial data. Three overall themes emerged from the data recorded by participants (P) in this study, including (1) interactive polling is enjoyable, (2) interactive polling is engaging, and (3) interactive polling helps my learning.

Theme 1: Interactive polling is enjoyable

In both face-to-face and online provision, participants mentioned the enjoyable nature of using interactive polling in class, with 43% face-to-face and 53% online participants making direct references under this theme. Participants in the face-to-face cohort reported Kahoot! to be a "*fun learning experience*" (P29) as participants were entertained and excited by the features presented within the polling tool. They also emphasised the easy nature of answering questions and the simplicity ensured they were not overwhelmed with large amounts of information, which could be intimidating after absorbing session content.

Participants in the online cohort also perceived interactive polling to provide a fun learning experience, enhanced by the attractiveness of the overall platform, from the bright colours and the "*groovy"* (P126) background music. Another feature that received positive reports from participants in the online cohort was the ability to choose a nickname, which meant the participant could remain anonymous while participating, increasing confidence answering questions as there was less pressure to respond with the correct answer. Participants also mentioned they enjoy undertaking a variety of learning activities, particularly interactive polling compared to other methods (Table 1).

Table 1:

Theme 1 – Interactive polling is enjoyable

Cohort	Subthemes	Quotations
Face-to-face	Fun experience	"Kahoot! is a fun, supportive learning environment." (P37)
	Simplicity	"I would like to use Kahoot! more in the future because of the fact that it is fun and easy without having to be intimidated by lots of information." (P33)
	Gamification features	"Fun way of learning. Visual/pictorial learning. Helps remember content easily." (P23)
Online	Fun experience	"I really enjoyed Kahoot! and would like it to be used more." (P79)
	Gamification features	"The aspects I particularly liked about Kahoot! were the colour, the leaderboard and the timed nature. Music and nicknames!" (P96)
	Anonymity	"Nicknames can be anonymous so for people who are shy and not so confident with the content don't feel embarrassed/nervous doing it." (P169)
	Variety	"Nice change up to learning class content." (P149) "Breaks up the monotony of theory delivery." (P162)

Theme 2: Interactive polling is engaging

Participants valued the competitive nature, immediacy of feedback, and interactivity of the polling platform, which encouraged engagement. These perceptions built the foundations of the second emerging theme, that interactive polling is engaging. It was found that 54% and 89% of the total participants in both the face-to-face and online cohorts, respectively, reported some aspect of using interactive polling as engaging. Participants in the face-to-face cohort perceived Kahoot! to be an engaging and interactive resource that enhanced interaction with peers. It was also reported that the interactive polling platform encouraged healthy competition between classmates, as well as with themselves, which could encourage dedicating additional revision time towards learning content. In addition, the polling platform presents itself as a tool that can motivate students to continue to study and enhance their knowledge in the content area.

From the online cohort, the engaging nature of Kahoot! was highlighted by reporting on the interactive nature of the learning tool, which promotes student participation in class activities. It was also indicated that interactive polling allowed participants to not only have competition with themselves to encourage learning but also introduced friendly competition and camaraderie between classmates. However, in constructive feedback it was noted that the time pressure and the competitive environment can undermine the purpose of interactive polling being a learning tool (Table 2).

Table 2:

Theme 2 – Interactive polling is engaging

Cohort	Subthemes	Quotations
Face-to-face	Interactivity	"Handy and involved method of study." (P63)
	Healthy competition with peers	"I particularly liked the competition between classmates." (P59)
	Competition with self	"Build the pressure formed in an exam room." (P9). "The competitive nature makes me want to study, which is something I don't do a lot of." (P26)
	Motivation	"It keeps us engaged and introduces some friendly competition to our learning which keeps us motivated." (P120)
Online	Participation	"It encourages students to interact and participate in the tutorials." (P85)
	Friendly competition	"It's very easy to use and competitive and helps me see how I'm going compared to my peers." (P95) "It breaks up the delivery of theory and the time limit, plus friendly competition, forces you to make a quick and accurate choice." (P146)
	Time pressure	"It's fun but can prioritise competitiveness rather than learning at times. A bit of pressure to answer the questions in time." (P86)
	Feedback	"The format is way more engaging than other polling platforms and we are able to get instant feedback!" (P114)

Theme 3: Interactive polling helps my learning

One of the primary themes that emerged from participant written responses to using interactive polling was that it was perceived to help with learning, with 64% of participants in the face-to-face cohort and 60% in the online cohort making comment. Students can practice their current knowledge, identify focus areas for revision and mimic an exam-style setting. The face-to-face cohort reported the beneficial use of interactive polling as a revision tool, as participants could note content they were unsure of and use these as areas to focus on for revision. Participants also reported that the interactive polling appeared to summarise the content learned within the lesson, which was helpful to reinforce content and solidify knowledge. It was also mentioned that the Kahoot! sessions motivated participants to perform better. Furthermore, participants indicated they enjoyed the multiple-choice question responses as this required additional deliberation of the answer and provided examples of the right and wrong answers, as well as it provided them with examples of the type of questions that could appear in an exam setting.

Participants in the online cohort also reported the beneficial use of interactive polling as a revision tool as it facilitates with the review of subject matter. In addition, participants stated that changing the format of concepts learnt in the session into questions can assist in the consolidation of concepts and provide guidance to the principal learning areas. Interactive polling was perceived to motivate participants to improve their performance in class activities, as well as their own understanding of content learnt in class, due to the polling platform putting-into-practice challenging concepts. Another recurring point of feedback from the online cohort was that they enjoyed the nature of the

questions, which was perceived to help with learning. However, in constructive feedback, one student reported that whilst they enjoyed the interactive polling platform as a whole, they did not personally like the multiple-choice question format (Table 3).

Table 3:

Theme 3 – Interactive polling helps my learning

Cohort	Subthemes	Quotations
Face-to-face	Revision	"Aid in my revision by identifying gaps in my knowledge." (P17)
	Solidify knowledge	"It was a good summary of the past lesson." (P44)
	Increase performance	"Kahoot! helps us learn and strive for the best." (P21)
	Exam preparation	"Multiple choice helps with exam which is good. Interactive and helps to test knowledge." (P39)
Online	Revision	"It gave me a good indication of what I needed to study, and what areas I was falling down in! …It was good feedback!" (P84)
	Consolidation of concepts	"Testing knowledge recall right after learning it ensures you learn much better." (P168)
	Increase performance	"I would like to use Kahoot! for summary questions at the end of each week, to motivate myself to understand everything learned during the week." (P117)
	Question format	"Changes the format of concepts into a question format." (P149)

Comparison of themes in face-to-face and online cohorts

Seventy participants (97%) in the face-to-face cohort and 72 participants (71%) in the online cohort provided responses to the optional written comments. Both cohorts reported similar results to the themes interactive polling was enjoyable and interactive polling helped with learning. 54% face-to-face and 89% online participants reported interactive polling was engaging. The occurrence of negative responses to each theme was low (Figure 2). For the theme interactive polling was engaging, 4% of face-to-face and 1% of online participants made a comment that disagreed.

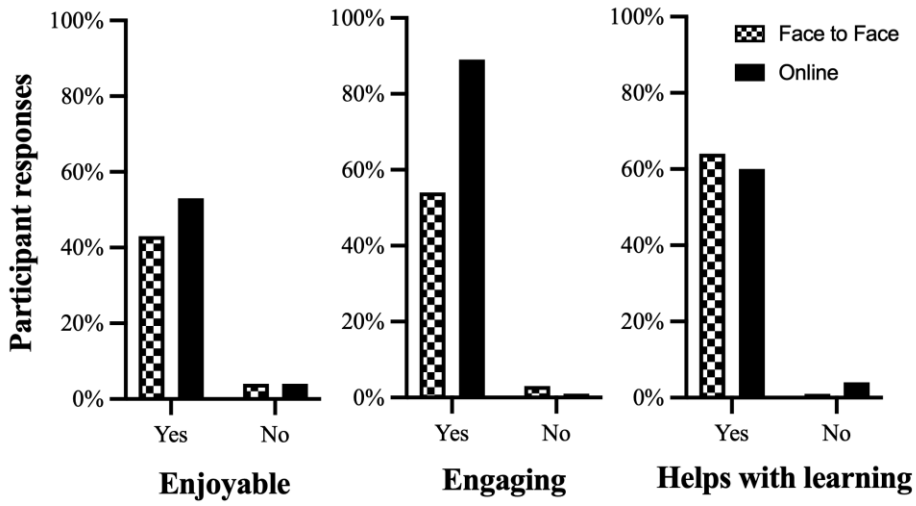

Figure 2:

Participants' overall perceptions of using interactive polling based on the emerging themes from participants in the face-to-face and online cohorts. Reported as a percentage of total participants who provided a comment, either positive (yes) or negative (no), related to the theme.

Participant perceptions

In addition to the written feedback, participants responded to a Likert scale survey regarding their overall perceptions of interactive polling. The interactive polling platform was rated highly across all four domains, with a mean Likert scale score above 4.2 (Figure 3). There were no significant differences between experiences using Kahoot! during a face-to-face or online session.

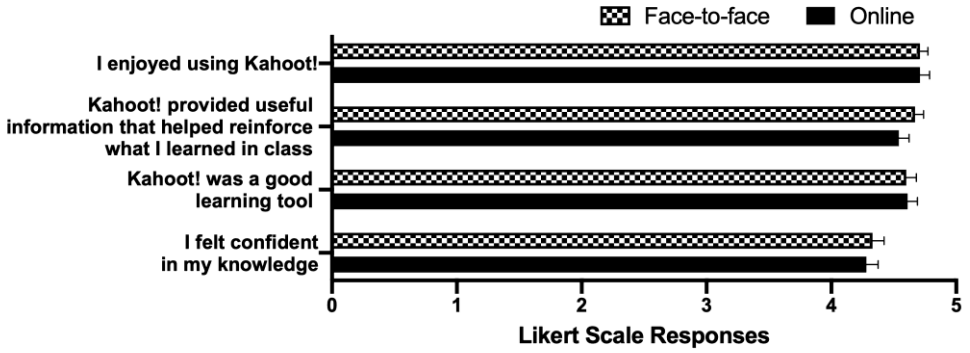

Figure 3:

Likert Scale responses of participant perceptions using the Kahoot! interactive polling tool, reported as mean ± SD. Responses are marked from 1 (strongly disagree) to 5 (strongly agree). No significant differences were found (unpaired two-tailed Student's t-test).

Discussion

The purpose of this study was to investigate learner perceptions of live interactive polling and identify whether this method of hand-on learning could provide equal experiences across various delivery modes in health science and medical education. Interactive polling was perceived to be an enjoyable platform that is engaging and assists with learning in tertiary education, with some particularly beneficial participant perceptions highlighted by the results.

Consistent feedback was provided from participants in both the face-to-face and online cohorts in support of interactive polling, where it was reported to be an enjoyable method of hands-on learning that provided a fun experience. A primary reason Kahoot! was perceived favourably was due to the attractive gamification concepts, including features known to be effective for creating fun, interactive lessons (Moro et al., 2020a; Moro et al., 2020b). Music and score points are important features of game-based learning tools to enhance the enjoyment and motivation of students and assist in improving overall classroom dynamics (Wang & Lieberoth, 2016). Remaining anonymous through nicknames on interactive polling platforms can foster enriched participation by ensuring students have a sense of safety and privacy, whilst promoting opportunities for open discussion and allowing students to compare differing opinions (Licorish et al., 2018). Making the delivery of content enjoyable is particularly important for those students learning in online remote classes (Moro & Phelps, 2022; Moro et al., 2020c). However, this can be challenging as students must be self-directed and are required to take on more responsibility (Borup et al., 2019). When students learn in a fun environment, levels of stress can be significantly reduced (Ismail et al., 2019), essential for health science and medicine students who are among the leading groups with heightened stress as a result of high workloads and demanding schedules (Damiano et al., 2021; Moro & McLean, 2017).

One of the most important factors for successful learning outcomes in higher education is student engagement, including facets such as collaboration with peers and interaction with educators (Boulton et al., 2019; Krause & Coates, 2008). In addition, Dewey (1986) highlights the importance of incorporating hands-on learning in the classroom to enhance student engagement, which is particularly crucial in an online setting as boredom in a computer-learning environment can result in poor learning outcomes and problem behaviour (Baker et al., 2010). An interesting finding in this

study was the greater proportion of online participants highlighting the enhanced engagement using interactive polling compared to face-to-face participants, suggesting the engaging nature was more apparent to those already studying on their computer and must leave the lecture capture application to open the interactive polling website. This may be due to the perceived passive nature of viewing a lecture captured remotely. Furthermore, the notion of 'witness learners' by Fritsch (1997) argues that even students who are not actively participating in online sessions are still engaged in the learning process as they observe the exchanges taking place between other students in both face-to-face and online settings. The interactivity promoted by polling is further highlighted by reports that interactive polling can break up the monotony of the delivery of class content. Students respond positively to the employment of live interactive polls during the delivery of course content as this allows for timely breaks, particularly during long lecture sessions (Licorish et al., 2017). There is a potential that an online lecture might be a more monotonous experience than a face-to-face provision, and this may further explain why participants found interactive polling to increase engagement in the online cohort over being physically present in the class.

Tertiary educators are increasingly challenged to utilise teaching techniques that promote student motivation and engagement to learn, as traditional teaching practices are shifting towards more active, self-paced, and often remote learning (Moro et al., 2020a). For future studies, the increased rate of responses that highlighted interactive polling was engaging from the online cohort provides a specific point of interest. Having an ability to connect, compete against, and communicate with other members of the class in real-time appears to have been well-received. In a hybrid class, polling presents one tool which can enable face-to-face and online students to both feel like they are learning with each other in the same class, at the same time. Throughout 2020, one of the major limitations of moving to "distance learning" due to COVID-19 restrictions was that online participants reported feeling deprived of communication with fellow students, and that there was no situation of social competition to provide opportunities for self-development (Ishmuhametov & Kuzmenko, 2021). Real-time interactive polling may be one step in the right direction that may facilitate this perceived area of need, and help all students feel like they are learning together in a more collaborative, and slightly competitive, environment.

Although the overall feedback received from both face-to-face and online participants was highly positive, constructive comments were received from both groups that warrant consideration. A small portion of participants who commented on the enjoyability of interactive polling made recommendations that the activity be used sparingly, to ensure the novelty does not wear off. Wang (2015) reported that the wear-off effect on engagement, motivation, and learning for Kahoot! is minimal, however, if it is used too frequently in many courses it can become a larger issue. This has been further supported by Yabuno et al. (2019), where participants in that study recommended that interactive polling be used to a maximum of once a week, but a minimum of once a month. In our study, mixed responses were received regarding participant perceptions towards the competitive environment created, due to the timed nature of scoring points, as well as the associated leaderboard. Whilst most participants in this study perceived the competition to be friendly between classmates, a small proportion also reported that the competitive nature coupled with the restrictive time limit could result in the need to guess answers, leading participants to feel upset when they answered incorrectly. This somewhat correlates to the literature, which identifies mixed responses to the competitive nature of interactive polling as a learning tool. In some cases, intra-class competition has been found to increase interest in the lesson and encourage ambition for success, which can encourage critical thinking skills and increase classroom energy levels (Bicen & Kocakoyun, 2018). Alternatively, competition may also invoke some adverse effects, such as heightened stress or nervousness as a result of the pressure to answer interactive quiz questions correctly (Głowacki et

al., 2018). One solution that might alleviate some of this issue could be to increase the time limit for responses, based on the difficulty of the question.

The use of a convenience sample presents a limitation to the universality of the findings. Additionally, the variety of background experiences of participants using technology was not considered during recruitment. A more representative cohort across multiple disciplines would enhance the relevance of this research to a broader cohort. Whilst participants perceived interactive polling to be enjoyable, engaging, and a helpful learning tool across different modes of delivery, further research would be beneficial to determine the effects of interactive polling tools on academic performance, such as through pre-post testing. In addition, future studies could benefit from assessing overall engagement between students in a hybrid-delivery subject. In our study, a higher percentage of the online students reported that they felt engaged by interactive polling compared to the face-to-face students, and uncovering the rationale underlying this might present an interesting future avenue for research.

Conclusion

Interactive polling is an enjoyable formative assessment tool highly regarded by first-year health science and medicine university students. Participants reported the interactive polling platform Kahoot! to be engaging and perceived that its use could enhance their learning and understanding of presented content. This study found that interactive polling maintains its suitability as a method of instruction across both face-to-face and online learner cohorts. This is particularly relevant in the modern educational landscape, where tertiary institutions are offering an increasing number of courses with hybrid delivery modes. The results provide evidence-based support for educators seeking to implement hands-on activities, such as interactive polling, in tertiary education and presents it as an ideal instrument to maintain an engaging experience for students.

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Declarations

The authors report no conflict of interest. Data is available on reasonable request by emailing the corresponding author. Ethics was approved from the University's Human Research Ethics Committee. No funds, grants, or other support was received. Informed consent was obtained from all individual participants included in the study.

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