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Navigating the Terrain:

Emerging Frontiers in Learning Spaces, Pedagogies, and Technologies

Leveraging Classroom Polling and Artificial Intelligence to Enhance Learner Engagement and Metacognition in a First-Year Anatomy and Physiology Course

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This paper explores the integration and impact of a polling solution (EchoPoll) enhanced with artificial intelligence (AI) in a first-year university anatomy and physiology course. The primary aim of this study was to evaluate the student and instructor perspectives of integrating this new polling tool into this course. The overall aims for the integration of the tool itself were to increase student engagement, provide real-time feedback, and facilitate deeper understanding of complex concepts in a subject area that has historically been taught in traditional and often didactic face-to-face modalities. Anonymous feedback gathered from two different cohorts of students from 2023 and 2024 regarding their experiences using the polling tool was overwhelmingly positive – particularly in terms of enjoying the interactivity, opportunities to improve comprehension of difficult subject matter in real-time and overall learning. This paper discusses the features of the polling tool itself, its application in different classroom scenarios such as lectures, laboratories and workshops, and how it supported both the students and the instructor to change their approaches to exploring anatomical and physiological concepts based on shared understanding and experiences.

Keywords: polling, metacognition, engagement, artificial intelligence, feedback, active learning

Introduction

Educational technologies continue to advance at a rapid pace, offering new strategies for enhancing student engagement and learning outcomes. For many years, classroom polling technologies have gained traction in tertiary education for their ability to provide instant feedback and foster interactive learning environments (Fagen et al., 2002). Classroom polling has been attributed to increased student engagement by promoting active participation - studies have shown that when students are encouraged to engage with classroom content in a more active and practical manner, they are more likely to be attentive and motivated (Smith et al., 2009). While not exactly new, and rather varied in terms of complexity (e.g. multichoice questions coupled with raising hands; clickers etc), polling technologies have advanced, such that they are now able to integrate with Learning Management Systems (LMS) and leverage the emergence of AI to rapidly generate questions and respond meaningfully to careful prompt engineering.

Classroom polling and selectively using anonymity settings can encourage participation from students who might ordinarily be reluctant to speak up in traditional question and answer approaches, particularly in larger classroom settings. Furthermore, carefully designed polling questions can acknowledge the diversity of student cohorts, allowing all students to contribute to classroom interactions and learning processes in a safe manner (Stowell & Nelson, 2007). The use of classroom polling can aid in better comprehension of course material while also fostering a more interactive, inclusive and engaging learning environment (Freeman et al., 2014). Anatomy and physiology are themselves particularly challenging subjects to teach, due to their complexity and the necessity for students to understand detailed and often abstract concepts, further compounded by difficult terminology and jargon. Historically, these subjects have been taught very didactically through lectures, laboratories, textbooks, dissection and experimentation (Singal, 2022).

This paper examines the use of a novel polling tool in a first-year university anatomy and physiology course, highlighting its effectiveness in improving student participation and comprehension in different classroom formats, and how it supports metacognition in a difficult subject area. Additionally, the incorporation of AI for

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question generation within the polling tool is explored, both in planned course materials and in real-time teaching scenarios – exemplifying its potential to enrich educational experiences for both staff and students.

Methods

The polling tool (EchoPoll) was integrated into a first-year anatomy and physiology course consisting of 207 (2023 cohort) and 278 (2024 cohort) students. EchoPoll join slides were created using the integrated EchoPoll plug-in within PowerPoint. In class and via livestream, students then used a secure web address with a unique EchoPoll session code or QR code from these join slides to access the polls in real-time as the class was being delivered. The course structure included lectures, workshops and laboratories, where EchoPoll was used to generate polling questions of various types, such as multichoice, true/false, short-answer, word clouds and hotspots.

With these question types listed above, the following scenarios were explored:

1. Gather attendance data (if needed)
2. Obtain instant feedback from students
3. Modify the direction of class discussions based on poll results
4. Identify and address areas where students demonstrated a lack of understanding
5. Conduct quick knowledge checks and deeper explorations of concepts
6. Utilise AI for generating diverse and contextually relevant polling questions, either in pre-formatted course materials, or in real-time during class sessions based on the flow of the lesson
7. Promote metacognitive awareness by encouraging students to reflect on their understanding and learning processes

Student feedback on experiences using EchoPoll was gathered via the Feedback tool in the institutional Learning Management System (LMS - Moodle). Participation in the feedback exercise was optional, and responses gathered were immediately anonymised through the Feedback tool settings in the LMS (in accordance with guidance from the institutional Human Research Ethics Committee and Information Management team).

Results

Feedback from students regarding the different use scenarios of EchoPoll was overwhelmingly positive. Of the 18 feedback participants from the 2023 cohort (8.7% of cohort), 83% were positive about the use of EchoPoll, whereas the remaining 17% were neutral or did not respond. Of the 52 feedback participants from the 2024 cohort (18.7% of cohort), 94% were positive about the use of EchoPoll, whereas the remaining 6% were neutral or did not respond.

From the qualitative responses of both the students and instructor, several broad themes emerged. These are outlined in Tables 1 and 2.

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Table 1. Emergent themes from student use of EchoPoll.

Theme	Findings
Increased Engagement	Students reported that they found the polling questions stimulating and engaging during lectures and workshops.
Real-Time Feedback	Instant feedback allowed the instructor to adjust the pace of the class and address misconceptions immediately. This was beneficial for both students attending in person and remotely via livestream, ensuring that all participants could follow along effectively and leverage off the feedback.
Deeper Conceptual Understanding	Poll results highlighted areas where students struggled, enabling targeted discussions and exploration of complex topics. Students appreciated targeted question types, such as hotspots, where they could link structure and function.
Effective Knowledge Checks	Quick polls served as effective knowledge checks, reinforcing learning and ensuring that students were keeping up with the course material.
Enhanced Question Generation	AI-generated questions provided a wide range of queries that were contextually relevant and diverse, maintaining student interest and promoting critical thinking.
Supporting Metacognition	Polls encouraged students to reflect on their learning, fostering metacognitive skills such as self-assessment and adjustment of learning strategies both during and after classes.

Table 2. Emergent themes from instructor use of EchoPoll.

Theme	Findings
Cohort Building and Recognising Diversity	Creating a sense of community through the use of different question types (e.g. a hotspot question showing a world map where students could 'pin' their birthplace).
Sensing Understanding	Being able to change the flow of a lesson based on visual representations of where the class was in their journey towards understanding a concept or idea.
Synchronicity for Distance Learners	Livestream participants could contribute to polls and use the chat function in real-time, increasing the sense of belonging to a cohort of students that may have ordinarily felt disenfranchised from participation.
Reminder of Learner Participation	Display of a polling question also gave a cognitive reminder to the instructor to encourage the online students to participate in the polls – something that often gets lost in the demands of managing a hybrid classroom.
Enhanced Question Generation	AI-generated questions, either in planned materials or developed in class in real-time, provided a wide range of queries that were contextually relevant and diverse, maintaining student interest and promoting critical thinking, and saving time for the instructor. The ability to upload a lecture slide deck and generate different questions quickly and efficiently helped to maintain the flow of classroom activity and minimise the time the instructor spent away from students to create questions.

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Discussion

The positive feedback from these cohorts of anatomy and physiology students aligns with previous research that showed how polling tools can make large classes feel more interactive and personalised, which is particularly valuable in complex subjects like anatomy and physiology (Caldwell, 2007). Kay and LeSage (2009) also reviewed the benefits and challenges of audience response systems, emphasizing their role in providing immediate feedback and promoting active learning, an outcome that was also highlighted across both cohorts of students in this paper. Polling tools also supported metacognition, the process of thinking about one's own learning, in these cohorts. Metacognitive strategies, such as self-assessment and reflection, are crucial for academic success, particularly in higher education (Dennis & Somerville, 2023). Engaging students in metacognitive practices can enhance their ability to monitor and control their learning processes (Tanner, 2012). By providing real-time feedback and encouraging reflection, polling can help students become more aware of their understanding and learning strategies, leading to improved confidence within the subject area. Students that are early in their higher education journey often struggle with being responsible for their own learning (Nuade et al., 2016), therefore integrating metacognitive supportive opportunities (like those offered by polling) can enhance the likelihood of academic success.

The integration of AI in question generation added another layer of sophistication for the instructor, ensuring that questions used were varied, relevant, and challenging. It was reassuring to note that some of the perceived benefits to the students (Table 1) were synergistic and reciprocal to those of the instructor, particularly around enhancing understanding of difficult subject matter and an appreciation for the real-time affordances that the AI question generation capabilities provided. This finding supports recent studies which showed that AI can effectively generate educational content that is adaptive and personalised to the needs of students, thereby enhancing the learning experience (Chen et al., 2020; Roll & Wylie, 2016). This capability is particularly beneficial in subjects like anatomy and physiology, where diverse and well-crafted questions can aid in better understanding and retention of complex course content and concepts.

The use of AI in education shows great promise in creating adaptive learning environments that cater to the diverse needs of students (Chen et al., 2020). AI-generated content can enhance the learning experience by providing personalised and contextually relevant questions, which is particularly beneficial in complex subjects. The potential of AI to support self-regulated learning, through personalised feedback and intelligent tutoring systems, further enhances the potential and emergent effectiveness of polling tools in educational settings (Roll & Wylie, 2016). For our institution, EchoPoll was an entirely new polling solution, which offered increased levels of sophistication in the types of questions that could be asked in a polling format, as well as increased agility to create questions quickly using the AI capabilities of the tool. The integration into PowerPoint, alongside the web-based interface, allowed for the instructor to store, modify and enhance learning content and polling questions easily.

Conclusion

Classroom polling with EchoPoll proved to be a valuable tool in the first-year anatomy and physiology course by enhancing student engagement and learning outcomes. Its features allowed for real-time adjustments to teaching approaches, deeper exploration of concepts, effective knowledge checks, and support for enhanced metacognitive approaches to learning. The positive feedback from students highlighted that polling tools can transform traditional educational practices, and that they can be further enhanced by capabilities of emergent technologies like AI. The ease of access to the tool for students through a web browser on smartphones and other web-enabled devices promoted equity and access across the cohorts of students, something that is at front of mind whenever we design course materials for our students. Furthermore, AI question generation cut down on time the instructor spent creating opportunities for formative feedback allowing more time to focus energy in supporting students in other areas of their learning journey. Further exploration of EchoPoll will examine the integration of this polling solution with other disciplines, and by

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including AI-driven content generation and analytics, could provide opportunities to create further cohesive and interactive learning opportunities. Finally, the integration of EchoPoll with the grading structure of the LMS will also allow for assessment opportunities via the tool itself, which is another exciting route to bolster engagement, real-time assessment and feedback.

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