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When teachers learn by observation: Vicarious reinforcement and student response systems in teacher education

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Abstract

A growing body of evidence suggests that incorporating a student response system (SRS) into classroom design can enhance the quality of teaching and learning across different instructional modes, particularly during distance learning. SRSs can facilitate active learning, discussion-driven pedagogy, and improve learner engagement. Nevertheless, studies have indicated that forcing teachers to use technology in their teaching practice may create first- and second-order barriers, such as technical difficulties and teachers' beliefs regarding the use of technology. This study aims to determine how these barriers to technology integration in schools can be lessened through vicarious reinforcement. The participants were pre-service and in-service teachers enrolled in a post-graduate diploma in teaching at one of the UAE private universities in Abu Dhabi. The research used a mixed-method collaborative inquiry design. The researchers and student teachers collaborated for one semester to examine AhaSlides and Mentimeter SRS's role in enhancing their engagement as learners. Findings revealed that the SRS applications enhanced student teachers' engagement and motivation to learn. Vicarious reinforcement learning experiences provided effective training on technology integration, built their technical confidence in using these applications, and influenced their decision to integrate them into their classroom teaching. There is insufficient research on the adoption of SRSs in the UAE's education system. Therefore, the present investigation aims to fill this gap by assessing the benefits of SRS platforms. The paper also offers insight into higher education (HE) and School leadership on vicarious reinforcement learning opportunities to support technology adoption that differs from traditional short-term training programs.

Keywords: vicarious reinforcement, student response systems (SRSs), educational leadership, teacher education, technology integration

Introduction

The incorporation of digital technology into teaching and learning has been a key focus in HE systems across the globe, especially with the growth of distance and blended learning. Student Response Systems (SRSs) are becoming more commonly used to enhance student participation and active learning in both face-to-face and online teaching modes. Studies have shown that SRSs promote participation and discussion-based teaching and learning, enabling instructors to be more immediate in their communication through the medium of formative assessment, while also providing instructors and learners with prompt feedback (Moorhouse & Kohnke, 2020; Skaik & Tumpa, 2021). Although these affordances have been well documented, integration of technology remains sporadic, and inquiry of teachers often reveals uncertainty or resistance to ongoing pedagogical use. Teacher capacity, receptiveness and commitment to integrating technology into their practice constitute immediate factors that can either facilitate or hinder technology integration and may surpass the challenge of access to technological tools.

The literature consistently reports that first-order barriers – such as lack of technical skill, time availability and institutional support - are documented alongside second-order barriers, including teachers' beliefs, self-confidence and pedagogical orientations (Ertmer, 1999; Abedi & Ackah-Jnr, 2023). These difficulties were most evident during fast-paced pedagogical transitions (such as those during COVID-19, due to which teachers were required to teach via unfamiliar technologies with little or no time for preparation) (An & Zakaria, 2022). Additionally, technology-centered professional development (PD) activities have frequently failed to produce long-lasting pedagogical change; thus, there is a need for other models of professional learning that attend to both technical and belief barriers.

Drawing on social learning theory (Bandura, 1977), vicarious reinforcement holds promise in helping explain how teachers gain confidence and motivation to adopt a new technology. Bandura (1971) described vicarious reinforcement as the process by which individuals witness others receiving positive consequences for certain behaviours. This then reinforces the observers' belief in their personal capabilities of enacting similar actions.

In educational contexts, viewing the successful use of technology by peers and the positive effect that it can have on learning may lower anxiety, breaking down held beliefs about technological adoption and encouraging a willingness to experiment. Though there is a significant body of literature on vicarious learning in the context of instructional design and collaborative learning, its application to the integration of technology in teacher education has not been widely examined.

In the UAE, this gap is much wider, as there are not many empirical studies on the pedagogical applications of SRSs. Although the schools and HE institutions (HEIs) are getting more and more digitalized, it is not so evident how teacher education programs may capitalize on live learning experiences in order to facilitate a sustainable integration of technology. Existing research on SRSs primarily focuses on student outcomes or tool effectiveness, with limited attention to how teachers' beliefs and confidence evolve through prolonged exposure and peer-supported use.

The current research aims to fill this gap by exploring the use of SRSs from a vicarious reinforcement perspective in teacher education. Therefore, the present study examines how technology-supported learning experiences with SRSs could help alleviate barriers to technological integration among pre-service and in-service teachers registered in a post-graduate diploma course in Abu Dhabi.

By employing a mixed-methods collaborative inquiry design over an extended period, the study offers a novel contribution in three ways: first, by foregrounding vicarious reinforcement as a mechanism for technology integration; second, by providing an empirically grounded alternative to short, decontextualised technology training models; and finally, by sending important messages to school and HE leadership on effective technology integration designs in teacher education. In doing so, the study advances current understanding of how sustained, participatory learning experiences can support teachers' confidence, decision-making, and long-term adoption of educational technologies.

The following questions have guided this study:

- How does integrating a Student Response System (SRS) into classroom pedagogy impact the engagement and motivation levels of pre-service and in-service teachers undertaking a post-graduate diploma in teaching at a private university in the UAE?
- What are the perceived benefits and challenges of integrating Student Response Systems (SRSs) into classroom teaching as reported by pre-service and in-service teachers?
- How does vicarious reinforcement learning, facilitated by Student Response Systems (SRSs), influence the technical confidence and decision-making of both pre-service and in-service teachers concerning integrating SRSs technology into their classroom instruction, both currently and in the future?
- How can vicarious reinforcement learning experiences, facilitated by Student Response Systems (SRSs), complement traditional brief training programmes as an additional method for integrating technology in teacher-training programmes in higher education in the UAE?

Literature Review

Technology integration

Technological changes have brought many innovations regarding how society handles various domains such as business, politics, economy, and education. The benefits of these advances in computer technology have far exceeded the original expectations, drastically changing the way people learn and communicate by facilitating the rapid transmission, reception, and processing of information (Dotong et al., 2016).

Classroom technology integration is impacted by various contextual, and school-related factors, which are further influenced by teachers' utilization of technology and their level of comfort and confidence (F. Liu et al., 2017). The pedagogical beliefs of teachers strongly shape their instructional approaches, making them inclined to adopt technologies compatible with their teaching styles and convictions on effective ways of learning (Akram et al., 2022).

Almekhlafi & Almeqdadi (2010) reported that teachers see themselves as very skilled in the implementation of technology in their instruction. Despite the many obstacles to their use of technology in education, such as technical problems and a lack of support, teachers were applying technology in their classes, although with varying success. For better technology incorporation, teachers recommended frequent PD along with technology-integrated material in the curriculum, increased interaction between schools and autonomy for choosing their course of study.

Brickner (1995) built on earlier educational change literature, particularly the distinctions discussed by Fullan (1991) and Cuban (1993), to conceptualize first- and second-order barriers to change in the context of technology integration. First-order change are small amendments to established practices that would lead to increases in effectiveness or efficiency of a system without substantially undermining the existing beliefs and everyday routines. An example of a 1st-order change is replacing paper-and-pencil worksheets with computer technology to review basic skills. Second-order changes, on the other hand, threaten existing assumptions of present practice and result in new purposes, arrangements, or functions. Such a change associated with technology is moving beyond the use of digital tools to simply deliver content (e.g., posting lecture slides on an LMS) to redesigning instruction based on student-generated digital inquiry, as students employ collaborative online environments to research, develop, and review multimedia projects.

Barriers to change encompass extrinsic and intrinsic factors that impact teachers' efforts to implement innovations. First-order barriers, extrinsic to teachers, include lack of access to computers and software, insufficient planning time, and inadequate technical and administrative support. In contrast, intrinsic to teachers, second-order barriers involve beliefs about teaching, computers, established classroom practices, and resistance to change (Ertmer, 1999). Addressing second-order barriers involves changes in teachers' beliefs and school culture.

Student response systems (SRSs)

SRSs, or audience response systems (ARSs) or clicker systems, are instructional technologies intended to query students and collect their responses, that have been used to engage students in multiple context including business, conferences and education. These systems come in various types to suit different teaching needs. Web-based applications such as Mentimeter, AhaSlides and Poll Everywhere allow voting from a computer or smartphone. Hardware clickers are employed by clicker systems for convenient response collection offline. Solutions delivered as an app (e.g. Nearpod and Socrative) have capabilities to offer teachers content-rich learning experiences (with the appropriate interactivity and media) when they want. They may also be added to well-known LMSs such as Moodle and Canvas to connect classrooms for assignments and grading, allowing professors to monitor students' work closely.

Game-based platforms, such as Kahoot and Quizizz, where prizes and competition are built into the learning, can help maintain student interest. At the same time, low-tech or open-source options like Plickers provide adaptable solutions for environments with limited resources.

The incorporation of new technologies including Student Response Systems influences the development of interactive learning environments. Such systems enable students to reply to questions from instructors, in live lectures or on in-class activities, using clickers, smartphones or laptops. Depending on the platform settings, responses can be anonymous or not, and they are collected and displayed in real-time. This allows teachers to see how students are advancing and where they may be struggling so they know where to focus their teaching. As Bruff (2016) discussed, in the context of education, SRSs are applicable in:

- Formative assessment: The SRS may be regarded as a means of keeping track of the teacher and learner for content comprehension while being taught.
- Active Learning: SRSs encourage active participation and attention in class since students react to questions and solve problems.
- Peer instruction: SRSs also allow students to engage in peer instruction by discussing their answers with one another and competing in group learning.

SRS can also record the attendance of students as they must answer during class (Kocak, 2022). In addition, SRS have the capacity to influence positively the learning environment by facilitating anonymous participation (Muir et al., 2020) and by promoting a more democratic way of answering and thinking about a question (Thomas et al., 2015). The anonymity that is afforded with the use of SRS also increases student success (Guarascio & Nemecek, 2017), and has been found to be positively related with increased engagement, motivation and attention (C. Liu et al., 2019). This results in increased quantity and quality of learner-teacher interaction and knowledge retention, as well as greater enjoyment of the learning process (Barrio et al., 2016), and in effective lessons (Ludvigsen et al., 2020). Nonetheless, some possible disadvantages of SRS are:

- Cost: SRSs are expensive to implement in lectures and have associated hardware, software, and infrastructure costs.
- External hardware required: Typically, SRSs require external hardware (such as clickers or mobile phone devices) to collect responses, which may increase the complexity and cost of the setup (Kocak, 2022).

Historical development of SRSs

Primitive forms of SRSs, like "clickers" or "audience-response systems," were already in use during the 1960s and 1970s (Thomas et al., 2015). These systems usually required specific hardware so students could respond to multiple-choice questions in the classroom. But the first generation of clicker systems was quite primitive, with limited features and the need to buy specialised hardware and software.

Extensive developments and enhancements in computers were carried out during the 1980s and the 1990s, which formed the basis for the design of high-level SRSs. The personal computer and later the Internet prompted a move of SRSs from hardware-based to software-based. With personal computers becoming mainstream and the Internet growing, SRSs transitioned from devices to application-based solutions. These developments allowed academics to use devices that they already owned, such as laptops and mobile phones, increasing the flexibility and scalability of SRSs' use (Kocak, 2022).

Significant growth in the use of SRS in educational contexts occurred during the early 2000s because of technological progress and greater attention on active learning pedagogies (Kay & LeSage, 2009). Today's SRSs include capabilities such as real-time feedback, data analytics and compatibility with LMSs.

Vicarious learning in education

The social learning theory, developed by Albert Bandura (1971), emphasises that learning takes place not only through direct experience but also from vicarious processes where learners witness other people's behaviour and the consequences of those actions. The theory postulates that cognitive development and behavioural alteration occur through attention to models, interpreting observed outcomes, and then enacting them themselves through imitation and internalisation of experiences. Bandura stated that seeing others succeed at a task can bolster their own confidence in the capability to succeed at the task, which is a clear statement about learning to be motivated through observing others (Bandura, 1977).

Observational learning enables individuals to make discriminations among the behaviour exhibited by the model, among the consequences of these behaviours, and among new alternatives of behaviour. As such, social learning theory emphasizes observation and modelling as primary mechanisms of learning new behaviours, skills and professional attitudes, and consequently provides a practical theoretical basis for understanding vicarious reinforcement within the context of education and training.

During modelling, individuals learn new behaviour or modify existing behaviour by observing others and then use that information as a guide to anticipatory regulation of their own behaviour. This is particularly important in adult education, including action learning (Yeadon-Lee 2018). Vicarious learning is the foundation for later performance in less familiar fields of endeavour. For example, successful vicarious learning supplies individuals with general principles and strategies that they can apply in new situations (Yeadon-Lee, 2018). In education, vicarious reinforcement is modelled when students learn by observing the consequences that others receive for their actions. For instance, a student watches another peer being praised for accomplishing a task. Then, they may be more likely to copy such behaviour because it gets rewarded. Conversely, if a student observes a peer being disciplined for unruly behaviour, then he/she may be less inclined to engage in the same behaviour. Vicarious learning has the potential to enhance the efficiency of educational experiences when properly employed.

Research on vicarious learning is informed by earlier research on active versus observational learning, including work by Schober and Clark (1989). Whereas vicarious learners in these studies showed comprehension, Tree and Mayer (2008) claim that the perspective of the speaker is more dominant than the dialogue structure. This illustrates the difficulty of matching the thinking processes of direct and indirect learners, a challenge that is related to empathic identification (Lee, 2010). Another study by Craig et al. (2000), showed that students can observe an interaction between a virtual instructor (which the student must consider as being human) and a virtual student, involving thought-provoking question exchange and potentially develop higher cognitive capabilities as an anchor for deep learning.

Some studies have sought to identify optimal applications of vicarious learning. For example, Rummel and Spada (2005) showed how vicarious learners benefit from multiple prompts during observation, in particular with respect to self-explanation. Upon analyzing the research on prompting, Gholson and Craig (2006) determined that self-explanatory and detailed inquiry is required for learning of both original participants as well as vicarious learners. Prompting can be automated, according to their review, but how successfully it can be done if students are aware that prompts come from a machine is uncertain. Vicarious learning will also most likely be influenced by the nature of the instructional conversations being observed, as we gain insight into what constitutes an effective tutorial for the participants. In a majority of instances, depth of learning is the same as effective learning (Mayes, 2015).

Vicarious reinforcement has important implications for learning and behaviour in educational settings, as it allows individuals to learn from others' experiences without directly experiencing the consequences themselves. It serves as a reminder that we need to offer students positive role models and examples for them to see and follow, but also the degree of influence that social interactions and peer influence can have on learning and behaviour.

Original contribution of the study

The originality of this study is that it highlights vicarious reinforcement as a theory-based and empirically observed mechanism in teacher education and PD, rather than an accessory concept in learning. Although the SRSs have been extensively investigated worldwide, empirical evidence is limited in the UAE, especially related to how teachers experience technology-integrated training. This study contributes with empirical evidence of how access to peer observation and modelling in school and HE training contexts is related to teachers' confidence and engagement in technology use. Moving beyond the constraints of brief, skill-focused training programs, the findings have broader implications for university and school principal leadership education and for those leading teacher education in reforming contexts, especially in relation to the development of teacher diploma programs and professional learning.

In the case of the UAE, this study provides context-specific evidence to the international literature and advances leadership scholarship by theorising technology integration, teacher learning and enabling leadership. As such, it presents a timely and theoretically informed contribution, adding contextually sensitive evidence to global debates over how to support professional learning for digitally mediated education systems.

Methodology

The purpose of this study was to investigate whether teacher candidates' confidence using SRSs in their future classrooms was influenced by vicarious reinforcement. This experience may be the result of observing effective strategies or the monitoring of others in a supportive or non-supportive environment.

Research design overview

This study adopted a mixed-methods collaborative inquiry design, which integrated qualitative and quantitative data to explore the influence of vicarious reinforcement on teachers' self-efficacy and decision-making for technology integration. Collaborative inquiry design was selected for this project because it invites all parties to be co-investigators in their own learning process and promotes critical and purposeful thought about one's own learning. To allow triangulation, data were collected over a semester and included a survey, reflective journals, interviews (semi-structured), and focus group discussions, yielding prolonged engagement.

The researchers partnered with student teachers in this study to investigate the contribution of AhaSlides and Mentimeter as representative SRSs applications in promoting student participation. AhaSlides and Mentimeter were chosen because they provide user-friendly accessibility and real-time interaction while being embeddable within existing LMS platforms. Other popular SRSs tools were avoided as they were either costly, offered limited flexibility, or were incompatible with the university's technological infrastructure.

The researchers acted as guides who role-modelled the use of AhaSlides and Mentimeter in classroom design. Student teachers engaged in structured reflective activities to articulate their thoughts and feelings about the impact of these experiences on their motivation to introduce technology in schools. The goal of the study was to support pre-service and in-service teachers in developing the capacity to design interactive, technology-integrated lessons.

In the current study, both the researcher and participants functioned explicitly as co-investigators, collaboratively generating findings. As reflective practitioners, participants provided insights into the advantages and challenges of integrating SRSs' tools into classroom design.

The researchers occupied the role of learners and change agents. As learners, the researchers sought to investigate how AhaSlides and Mentimeter might affect student teacher engagement and motivation particularly during online instruction. The researchers, concurrently, acted as change agents, responsible for supporting positive technology infusion to help teachers reconsider assumptions and explore alternative pedagogical approaches (Hashem, 2013). Attention to teachers' first- and second-order barriers to change (Ertmer, 1999) was therefore central to the study. First-order barriers, categorised as extrinsic, included technological challenges and teachers' orientation to SRSs' tools. Second-order barriers were intrinsic and involved challenging and reshaping teachers' beliefs about technology use in learning (Ertmer, 1999).

Context and participants

The study was conducted within a post-graduate teacher diploma program offered by the education department of a private university in Abu Dhabi. AhaSlides and Mentimeter were integrated into three academic courses (Education in the United Arab Emirates, Classroom Management, and Educational Psychology), taught in English and extending over 13 weeks.

Data collection methods included anonymous surveys, semi-structured interviews, focus group discussions, and reflective metacognitive memoing (brief, ongoing reflective notes). Memoing captured learning processes and examined the impact of the experiences on teachers' beliefs and motivation to incorporate technology in their classrooms.

There were 140 in-service and pre-service teachers who took part in this research from three courses. Participants were invited at the beginning of the semester and asked to maintain reflective journals documenting their technology use in each class. Participants were encouraged to reflect on how technology enhanced their practice and what they experienced during implementation.

As part of the inquiry process, in-service teachers voluntarily transferred these practices to their own school classrooms where they embedded SRSs' tools in lesson plans to activate prior knowledge, check understanding, and promote discussion. In service teachers designed interactive lessons using Mentimeter and AhaSlides to gather real-time feedback, pose questions, display responses anonymously or with identifiable responses, evaluate student understanding, and adapt instruction accordingly.

To support effective SRSs use, the following features were emphasised:

- Interactive Q&A design aligned with learning objectives;
- Promotion of peer learning through collective analysis of responses;
- Assessment of understanding using multiple-choice and open-ended questions, and;
- Case examples illustrating cross-disciplinary use.

These practices and design features were explored, refined, and evaluated through ongoing dialogue and reflection between the researchers and participants. This collaborative process informed both classroom experimentation and the interpretation of participants' experiences, positioning teachers as active contributors to the research rather than passive subjects. Collaborative inquiry is a methodology of research in which the subject of the research is emphasized as a co-researcher in order to promote cooperation and a participatory stance in the creation of knowledge, actively involved in the research process (Carpenter, 2017).

The research methods were intentionally chosen to enable robust inquiry as they were conducive to the collection of rich, contextualized data. Data analysis and interpretation occurred under the joint leadership of the researchers and participants in the study. Reflection was cumulative, and led to the identification of significant themes, patterns and stories which supported the development of sophisticated understandings of the phenomena under investigation and guided subsequent actions/interventions. Collaborative inquiry contributed to high-impact learning, the growth of professional capacity, and professionalization. Participants were able to think more deeply about the work, challenge, taken for granted assumptions, and engaged in a learning process that resulted in changed behaviour.

Data collection and analysis

To collect data, three main tools were used: surveys, semi-structured interviews, and focus groups. These tools facilitated triangulation and diversified emerging perspectives, allowing for deeper insight into the experiences of the participants.

Survey questions were developed based on expert review and pilot testing and were administered at the end of the semester. Content validity was evaluated by educational technology and pedagogy experts, and consequent modifications were made to enhance the clarity and relevance of the survey. The dimensions of the survey were operationally defined as follows:

- Engagement: It evaluates how actively students are participating, concentrating, and interacting with SRSs tools during class activities.
- Motivation: This indicates the degree to which students feel that the use of SRSs tools contributes to their motivation, interest in learning, and continuous participation in class activities based on what they are doing.
- Satisfaction How useful and easy to use the SRSs tool seems to be, and the overall learning experience by using the SRSs tool.

The data on engagement was used to interpret the effect of SRSs on participation, the motivation data on the effect of SRSs on attitudes towards learning, and the satisfaction data on the overall success of the implementation of SRSs.

A rigorous procedure of mixed analysis was implemented. Descriptive and inferential statistics were applied to analyse the quantitative survey data in relation to engagement, motivation and satisfaction. The researchers used Julius AI, an AI-assisted statistical analysis tool to compute reliability coefficients, conduct factor analyses, and carry out comparisons between groups. Cronbach's alpha was calculated to test for reliability, followed by exploratory and confirmatory factor analyses to test construct validity. ANOVA and independent-samples t-tests ($p < .05$) were performed to analyse group differences with respect to employment status and teaching experience.

While Julius AI did perform the statistical calculations, analytic decisions and interpretation of results were done by the investigators; results were cross validated to assure inferential consistency and thereby contribute to transparency and reproducibility.

The qualitative data from semi-structured interviews, focus groups and reflective journals were analysed thematically using iterative coding techniques. The first stage of open coding produced categories, which were grouped into themes related to confidence, motivation and technology decision-making.

A participatory qualitative analysis methodology was employed whereby the researchers and participants jointly interpreted data in debriefing sessions. It was also a shared meaning-making process and enhanced the trustworthiness of interpretations.

Triangulation between the qualitative and quantitative results provided greater confidence in the analysis (Creswell & Clark, 2017).

Ethics

The study was carried out with careful consideration for ethical guidelines. Anonymity was ensured, informed consent was acquired, participation was voluntary, and participants were free to withdraw at any moment.

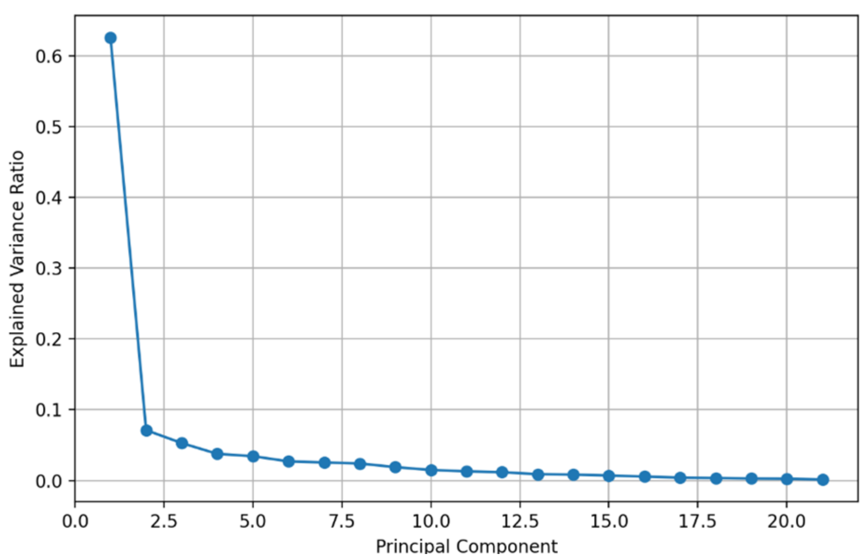
Findings

The reliability of the survey, the factor structure, and the group comparison tool used to gather user opinions of AhaSlides and Mentimeter are all covered in this section. The survey's Cronbach's Alpha = 0.965, suggesting high reliability. This suggests that the questionnaire items are consistently measuring the targeted constructs.

To identify the number of components driving the survey, a Principal Component Analysis (PCA) was conducted.

Figure 1

Scree plot for factor analysis



A scree plot and the explained variance ratios were produced, which helped identify the number of meaningful components among the ratings. The first principal component (PC1) explains about 62.58% of the variance alone. The subsequent components (PC2, PC3, etc.) contribute lesser percentages, where PC2 contributes about 7.11% and PC3 contributes about 5.28% of the variance. Overall, the scree plot and variance ratios suggest a dominant first component, with additional smaller components contributing to specific dimensions of the SRSs experience. The key indicators for each of the first three components were extracted and are referenced by:

- For PC1 (classroom participation) (see Using AhaSlides/Mentimeter improved participation of the students: -0.877 through AhaSlides/Mentimeter was user-friendly and convenient: -0.849): The strongest contributions come from items related to student participation, comparison of responses, overall classroom interaction, student engagement, and the perceived convenience of the tool. The high (absolute) loadings indicate that these items are major drivers behind the first component.
- For PC2 (paying attention) (see AhaSlides/Mentimeter helped me pay attention in the class: -0.515 through Using AhaSlides/Mentimeter improved the classroom interaction: 0.353): Items like "helped me pay attention in the class" and "encouraged class discussion" stand out. This implies that PC2 could be measuring something about attentiveness and engagement differently than the general positive interaction indicated by PC1.
- For PC3 (technical difficulty) (see I found no technical difficulty using AhaSlides/Mentimeter): -0.548. The factor was influenced mainly by reasons such as the absence of technical problems and ease of access feelings and quick feedback. This might be pointing to a distinct dimension related to the application's technical ease and supporting quality.

Collectively, these elements were consistent with the focus of the study on participation/engagement (RQ1), perceived benefits and challenges (RQ2), and technical confidence (RQ3).

An analysis of variance (ANOVA) was run to compare the groups. Results of ANOVA are shown in Table 1.

Table 1

ANOVA results

	count	mean	std	min	25%	50%	75%	max
No experience	7	4.4149659864	0.3155269929	4.0476190476	4.1904761905	4.380952381		
1-2 years	10	4.5733333333	0.6608607731	3	4.4589285714	4.925	5	5
3-5 years	20	4.2928571429	0.8770012322	1.0952380952	4.1071428571	4.5714285714		5
5+ years	28	4.6494897959	0.4338850284	3.7619047619	4.4642857143	4.8571428571	5	5

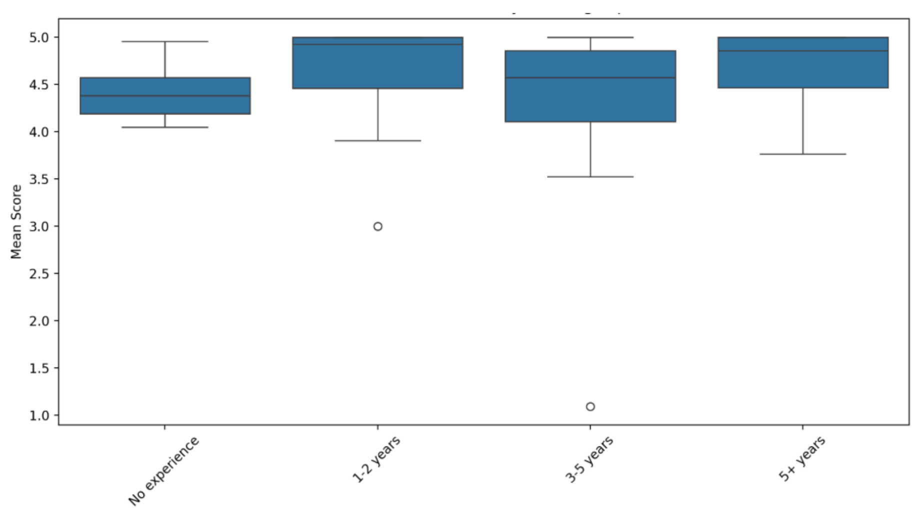
Looking at the mean scores across experience groups:

- No experience teachers: Mean ≈ 4.41 (SD = 0.32)
- 1-2 years' experience: Mean ≈ 4.57 (SD = 0.66)
- 3-5 years' experience: Mean ≈ 4.29 (SD = 0.88)
- 5+ years' experience: Mean ≈ 4.65 (SD = 0.43)

As can be seen in Figure 2, the mean scores were high for all the experience groups (all means > 4.0). While there appear to be differences in central tendency and variability, the ANOVA suggests that these are not statistically significant (p > .05).

Figure 2

Distribution of mean scores by teaching experience



An independent-samples t-test was conducted to check differences in the preference for AhaSlides/Mentimeter versus the classic PowerPoint presentations between working teachers and their non-working counterparts.

- Teacher status unique values: ['No' 'Yes']
- Number of working teachers: 48
- Number of non-working teachers: 31
- T-test results (t-statistic and p-value): t-statistic: 1.04 and p-value: 0.302

Since the p-value (≈ 0.302) is greater than 0.05, it indicates that there is no statistically significant difference between working and non-working teachers regarding their preference for using AhaSlides/Mentimeter over traditional PowerPoint presentations.

Key Findings:

- All the experience categories exhibited positive overall ratings (means > 4.0 on a 5-point rating)

- The highest mean rating (4.65) was observed with the 5+ years of experience category.
- The 3-5 years of experience group showed the most significant variation (SD = 0.88).
- Although these differences are apparent, $p > 0.05$ indicates that they are not statistically significant.

In conclusion, the results show that opinions of AhaSlides/Mentimeter were generally favorable and consistent across teaching experience and work status, indicating that all participant groups thought the tools were simple to use and beneficial.

Vicarious reinforcement through positive learning experiences with AhaSlides and Mentimeter

The research findings showed that using AhaSlides and Mentimeter applications improved students' engagement in learning and motivated them to learn better. They initiated better inclusion by giving all students a voice and making them share their ideas without the fear of peer or instructor pressure due to anonymity in answers. They also initiated beneficial data concerning students' attainment towards learning outcomes and provided a practical training platform for teachers concerning technology integration. The findings also confirmed the initial argument of this study. Teachers' reflections showed a change in beliefs about using the SRSs. The fact that they had to deal with it for 13 weeks provided extended training essential in constructing their technical confidence about using SRSs.

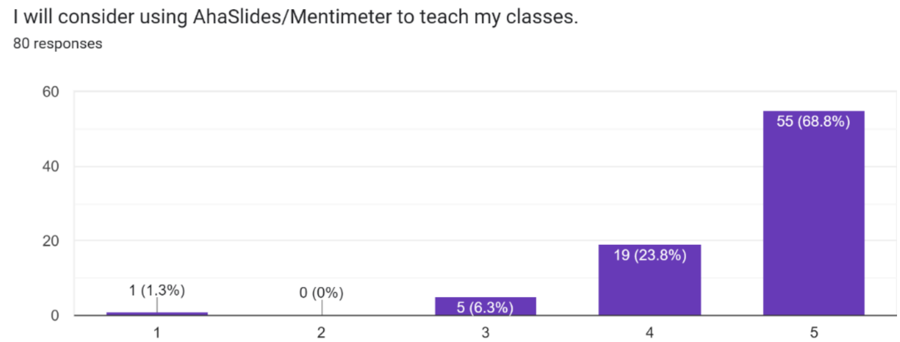
There is a strong overall synergy between qualitative and quantitative results, as the qualitative evidence highlights that continued use of AhaSlides/ Mentimeter supported by peers, helped to foster engagement, inclusion (especially for quieter learners), and build confidence, in line with a vicarious reinforcement mechanism (RQ3 – RQ4).

Enhancing engagement

Participants acknowledged that AhaSlides and Mentimeter were effective tools to bring into their classrooms and that they helped keep students focused when attention began to wane. The study showed that student teachers are motivated to use SRSs in teaching to promote student participation. A total of 92.6% of the respondents (see Figure 2) demonstrated this tendency and stated that they would think about utilising AhaSlides and/ or Mentimeter in their next class sessions.

Figure 3

Teachers' intention to integrate AhaSlides and Mentimeter into classroom practice



Participants preferred AhaSlides/Mentimeter over other alternatives, such as Kahoot, for their effectiveness in increasing engagement levels. Teachers explained that the reason for this choice was the functionality of the instruments and the perceived suitability of their own needs in teaching. Teachers who participated in the research have aligned the use of AhaSlides with their teaching fields. A French teacher, for instance, gave the context in which she could utilize AhaSlides for overcoming difficulties that students encounter when they change to online learning, especially when it comes to writing, as in this instance:

> When I was teaching online, I had a big problem. Some students who demonstrated high levels of proficiency in a face-to-face context appeared to have difficulties when performing online (particularly for written tasks). This tool, if it existed, would have enabled students to respond individually to the shared screen with teacher interaction and, later, student engagement.

The teacher emphasized that clear communication is essential in active learning scenarios, especially in the context of language barriers. She found SRS technology to be particularly relevant during online teaching:

> Face-to-face exchanges are in French, to which some visual support or gesture can be added to facilitate understanding. But online, I need to switch into English from time to time, which is difficult because it's not my native language. That has spurred parents who believe there should only be communication in French to complain, even though using English cannot be avoided. The alternation between languages can be challenging, particularly for teachers who are non-English speakers. An instrument like AhaSlides could help so that we could use both languages, by inserting queries in English, but carry on the conversation in French for those who preferred it.

One teacher also commented that teachers need to "evolve and adapt" in the changing world of education and that they must "find new ways to engage students," who are more used to accessing resources and using methodologies online. She is motivated to try new and stimulating techniques in order to pique her students' curiosity about learning.

Another participant argued:

> Doctor, with your permission, I want to make a point on another subject. I've found AhaSlides engaging, and the class remain focused. I also think it is a time issue solution, because in a big class you can't have every student talking at once. The slides let everyone have a voice and contribute, and save time, too.

The participants claimed that questions in different formats were needed for different levels of students. Such a blending of question types appealed to a large number of student teachers. They pointed out that the formats can be mixed (e.g. multiple choice, true or false and open answers) to increase the level of interactivity. The diversity of these slides makes it easy to create different types of questions on one presentation, which was generally a desirable feature for teachers.

In addition, students contrasted the experiences in the SRS with the other sections with a traditional presentation format. One participant said:

> I was trying to point out the fact that including interactive components into the lesson removes the monotony factor and changes the mood of the lesson altogether. A normal PowerPoint lesson is the teacher talking and showing the information directly to the students and then going onto another task. But when you layer on the interactivity within the lesson, it's more fun. To add to my colleague's point, it's very easy to go on autopilot in a traditional lecture even when you are trying to pay attention. But with interactive AhaSlides/Mentimeter, there's a lot more question types that appear and it's more fun. This could include queries that are multiple-choice, open-ended, or even self-assessment scales. It brings some dynamics into the learning process vs a traditional teacher/lecturer giving random questions. In the classes I've had before SRS, I would most definitely find myself spacing out, which really isn't what you want to be doing. Having the PowerPoint slides and being able to read them whenever I felt like, I just wasn't paying that much attention in class. It felt a bit odd not to engage, and twice I just sat and stared at the slides without really participating. But my grades have been improving ever since I began using AhaSlides/Mentimeter. Since I have the feeling that I may be quizzed at any moment, I should be better prepared, I tend to be less sleepy and more attentive in class. It’s made noticeable improvement in my grades.

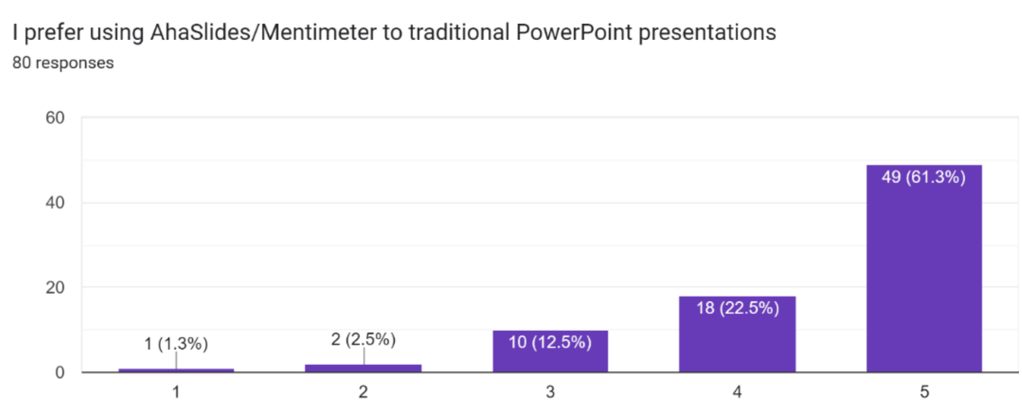
To the participants, these exchanges were multifaceted and were not in the form of a Q&A. They came in different forms that enabled the participants to make sense of the questions and to respond to them in more than one way. Participants in the discussions recounted how it helped them think more reflectively about questions and let them “give reasons” for their views:

> I thought the embedded interactive elements throughout the talk really worked to help keep strong participation. Usually, students are reluctant to answer questions because they are afraid of being wrong. But in this process students' names were visible first, then they have rights to say whatever they want to share their ideas and opinions. This method led to many debates amongst students. The presentation of contrasting approaches meant that students had to justify their own thinking, resulting in interesting interactions with both the presenter and their classmates.
>
> Integrating content with AhaSlides felt more natural than any other interactive quiz or presentation tool. None of the other tools allow you to integrate the presentation material and video content with your teaching like AhaSlides/Mentimeter. Personally, it worked better for me to have the teacher, the material, and the questions all in one place. This solution worked best, in my view.

The findings from the interviews were also supported by the survey data, as 83.8% of them strongly agreed that they would recommend AhaSlides / Mentimeter over traditional PowerPoint presentations while teaching their class (Figure 4).

Figure 4

Teachers’ preference for AhaSlides and Mentimeter



Moreover, in the comments section of the survey one participant stated:

> I am just so inspired by the type of platform and tool AhaSlides that we used in our course and I have started using it in my classes with my students and they love it too... So engaging and interactive, students get motivated and they all participate in the quiz, polls and sharing their opinions and therefore it really helps to guide the students according to their needs.

Student's Presence

The participants also emphasized the function of AhaSlides/Mentimeter in maintaining students' presence via attendance-based participation. One student said:

> I thought the university's policy on attendance was pretty strong. However, a better strategy was to begin each class by telling students their attendance would be taken and that participation would be observed and factored into attendance. This is a way to keep students active and ensure class attendance.

Another participant mentioned:

> I think mandatory attendance will make majority of the students go for the lectures, but it is the interesting SRS which really attract and make the students engage (in the sense of enjoying the lecture and getting sense from the lecture). The slides provide students with a goal and motivation, and lectures are turned into entertaining and dynamic experiences with group participation, which makes students think that they are part of a group and not simply looking at the materials alone.

Another participant argued:

> Yes doctor. The slide was the first thing shown, like when you get students to enter their names. This one step serves multiple purposes, including attendance. So, we don't have to worry about whether a child came to class or not, since their name is already logged. We also can measure their participation by questioning and getting their views in different ways, like multiple choice, explanations or short answers. This combination of activities was very interesting and entertaining, and it sustained my attention in all the presentation, it kept me concentrated.

These perceptions were confirmed by the responses from the surveys and are shown in the following figures. Eighty-three percent (Figure 5) agreed that use of AhaSlides/Mentimeter motivated them to join the session, 87.6% (Figure 6) agreed that it helped them to concentrate during the class, while 84.8% (Figure 7) agreed that Using AhaSlides/Mentimeter made them more interested in the topic.

Figure 5

Perceived motivational effect of AhaSlides and Mentimeter on session attendance

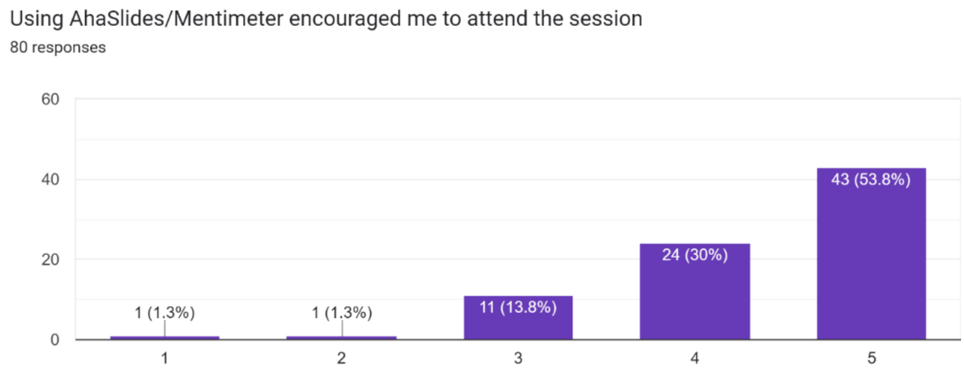


Figure 6

Perceived impact of AhaSlides and Mentimeter on attention during class

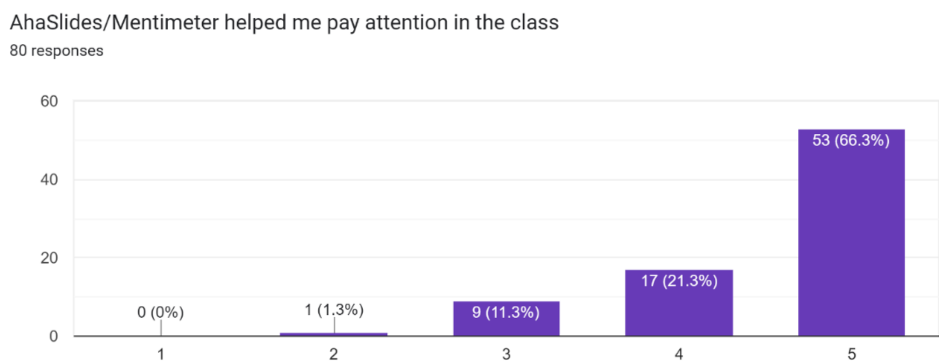
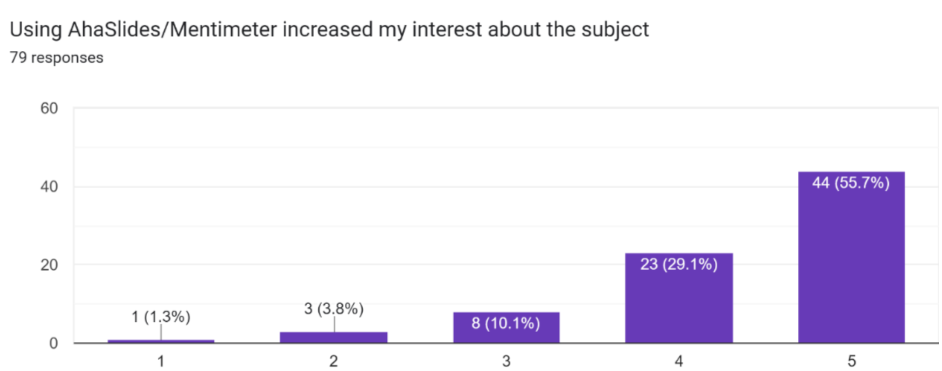


Figure 7

Increased interest in the subject through AhaSlides and Mentimeter use



Different learning styles

The inclusion of SRSs also made it easier to cater to different learning styles. One student contended:

> I just want to say that I myself prefer talking in the chat or in a text form to express my opinions. I thought it was more efficient than talking, so I will definitely use it in my future classes. I think that all the students were very engaged with this activity, because attendance is essential for any lesson to be successful. The whole class was there and active, because you cannot move forward without the students. As a result, all students can participate in the content, and the learning is inclusive and complete in itself.

The teachers said that sessions that featured interactives such as explanations, visuals and questions were one-of-a-kind and fun, and engagement was up. They also said that instantaneous feedback and varying formats of questions made the learning more vibrant. The accompanying activities for support within the lectures maintained high levels of attention and participation.

One student said:

> I prefer multiple-choice questions over having to write out answers because I find it more engaging and interesting to choose from options. Comparing my answers to others visually helps me see where I went wrong and motivates me to review the material to improve my understanding.
>
> I am a competitive person, so when I notice that others are answering questions correctly, it motivates me to study harder and search for answers more diligently. I find it beneficial to observe the responses of others.

Ninety-five per cent (Figure 8) of the participants strongly agreed that using AhaSlides/ Mentimeter motivated them to participate in class, with 97.5% (Figure 9) strongly agreeing that SRSs helped them compare their responses with others.

Figure 8

Motivation to participate through AhaSlides and Mentimeter use

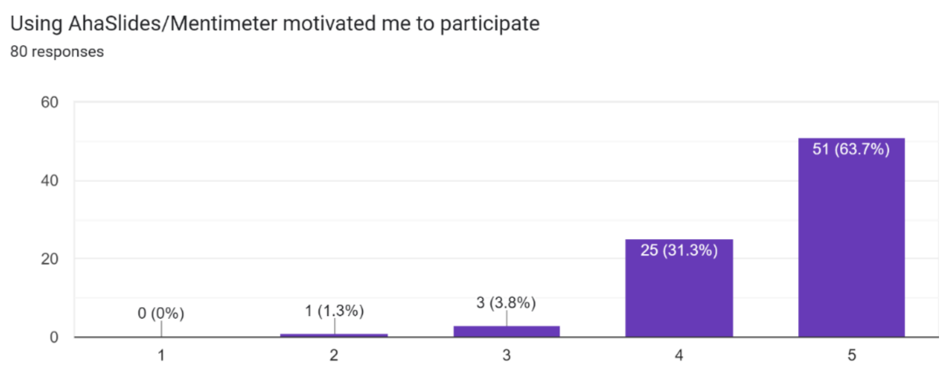
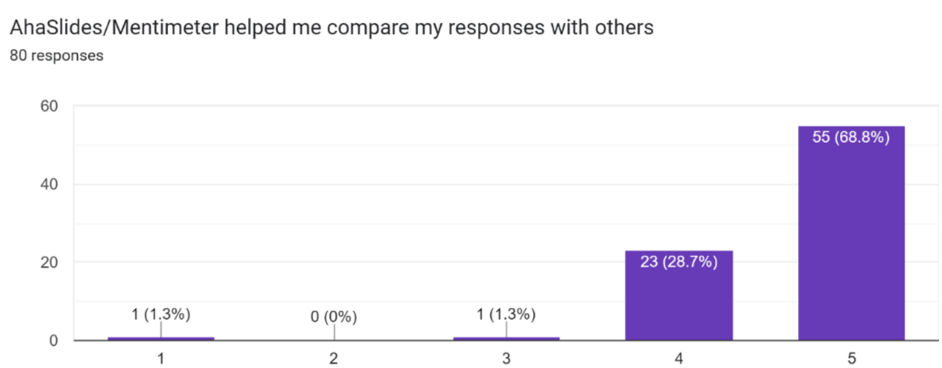


Figure 9

Peer comparison enabled through AhaSlides and Mentimeter use



However, some participants advocated a balanced approach toward their preference:

> I enjoyed both approaches. I preferred the competitive aspect where we would calculate the right answers and someone would be declared the winner. I recall a time when I achieved first place and the computer displayed a message that seemed trivial, but it was still enjoyable. I also appreciated the other style where we shared our own opinions. Even though we are now adults, we still find it engaging. For example, some would signal agreement, request elaboration, or share an alternative perspective. And this type of commentary was fun to me as well. Therefore, I found value in both methods.

Another participant said:

> Yes, employing SRS in classrooms can be useful for evaluating students' learning and prior knowledge and for raising their attention to the discussed content. Along with classical tools for assessment, such as clickers, the use of visual presentations is particularly effective in kindergarten classes, where children are

> able to get help from visual tools. The platform supports the inclusion of visuals to enhance learning, and students are motivated to participate through interactive features.

The interactive class environment was perceived positively as it increased attention and concentration among students and helped them actively participate. The participants appreciated the mixed question types and the multimedia components (such as polls, visuals, videos, and images). They too emphasized the advantage of timely answers and, for a few, an inspiring competitive sense. The teacher's capacity to keep track of, and help with, the students' progress was also commended:

> The use of the interface was simple enough, as you have two ways to enter the information… by typing manually or by scanning a QR code. This allowed for a natural flow which brought the students right into the topic and the discussions of the class. It gave even the quiet students who didn't want to speak an opportunity to share their ideas.

Supporting reserved learners

Few teachers mentioned that they had seen students disengage when they were teaching, and that if they had used more SRSs, they would be better teachers. In addition, teachers said AhaSlides/Mentimeter can increase student involvement and interaction, and it can help shy students speak up:

> Making use of written communication might be helpful especially for quieter students who like to type their answers rather than say them out loud. This type of learning allows students to communicate their ideas in a concise and to the point manner. Such an approach has potential for enriching teaching and learning experiences and should be considered for application in the next school year.

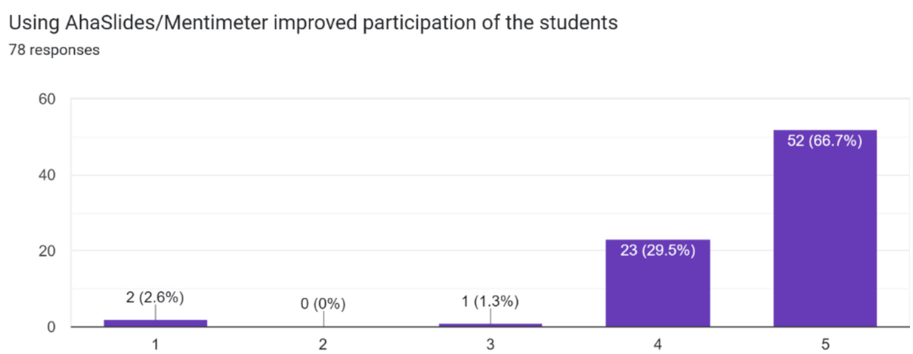
Another student said:

> Can I add one more thing? This is not to say that embarrassment cannot still happen, but this is to help cater to the needs of certain students like myself who are a little shy to speak in class. People want to participate and have a positive impact, whether that's through something simple like liking a post or dropping a quick comment. They don't have to feel embarrassed about not joining in, even if they can't answer a question. This inclusive atmosphere is in stark contrast to previous experiences where people were expected to be put on the spot if they didn't know an answer, which could be quite intimidating. While now the atmosphere is more laid-back and welcoming. Moreover, not knowing the answer is also a bit embarrassing, especially when you are speaking to an expert professor.

In the surveys, 96.2% (Figure 10) strongly agreed that the use of AhaSlides/Mentimeter enhanced the participation of the students in class.

Figure 10

Impact of AhaSlides and Mentimeter on student participation



The interviews emphasized the importance of peer participation in learning. The sharing of opinions also had the effect of expanding views among the class members. Participants recounted an environment of learning that was conducive to exchanging and co-construction of ideas. The results of the survey showed that 81% (Figure 11) of the students agreed that using AhaSlides/Mentimeter made them learn the content of the course better, and 87.4% (Figure 12) of the students agreed that the SRSs assisted them in applying what they learned.

Figure 11

Perceived impact of AhaSlides and Mentimeter on content understanding

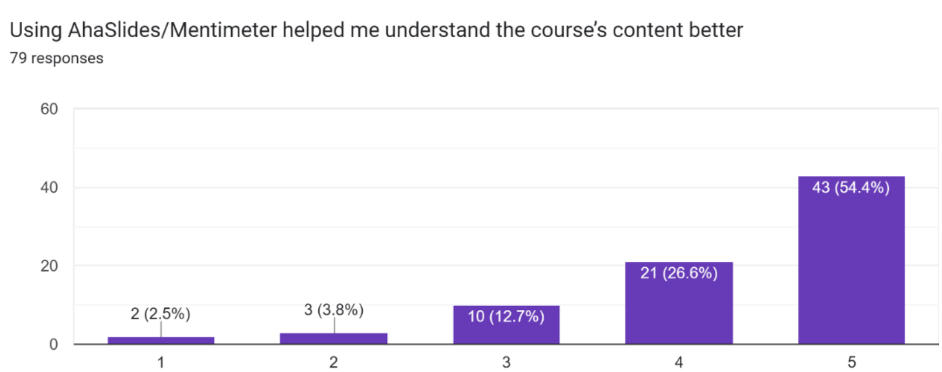
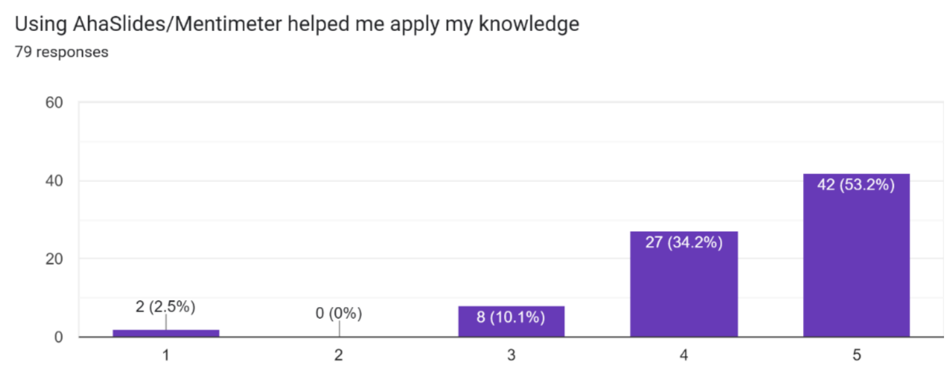


Figure 12

Perceived impact of AhaSlides and Mentimeter on knowledge application



In the survey comments, one respondent explained how the AhaSlides experience influenced their motivation and likelihood of future use:

> I enjoyed using AhaSlides. When the professor reads our answers, speaks out loud and shows that she liked them, we get motivated. Seeing other people's answers also helped to expand my understanding. I'll use it in the future when I get a job! Thank you, Doctor.

Also, another respondent remarked in the comment section of the survey:

> As an introvert, this has inspired me to voice my opinions more, and be more confident in my opinions and responses.

Allowing students to respond individually was also beneficial. It was a place for everyone to say what they thought without the fear of controlling the conversation. That compromise allowed both for strong grounding in participatory discussion and for each student to have a vigorous say in the conversation, and it produced a wider-ranging discussion.

Another previously raised issue was the adaptability of the questionnaire format chosen. the possibility of tailoring questions to activity context (for example a poll to know the level of experience, or a call for words of encouragement). These and other similar techniques facilitated diverse experiences for the participants, which gave vitality to the overall flow and made it engaging for all.

The preference for short answers (multiple-choice or short-answer formats) also helped to focus the discussion. In directing the flow of ideas among a large number of people, SRSs have been found to be especially useful. While having a multitude of answers at the same time could appear confusing, it all boiled down to a brainstorming session, and it gave the students a chance to think about different answers. One student argued that:

> I think it makes for much stronger engagement. Everything is turned into a chance for an interactive experience and the fast learning of a great deal of knowledge. The expert is the teacher, but all who attend the live event are able to

> express their views through a voting system. I definitely think it generates more engagement than those other ways, and that's exactly how I feel.

Many educators report they will continue to use AhaSlides/Mentimeter as a teaching aid. In line with previous results, some students may be reluctant to participate actively in oral interaction. Thanks to the incorporation of SRS-based interactive exercises, students are encouraged to express their ideas openly without any concerns about being evaluated or criticized.

Challenges

The findings of this study suggest that although the participants were keen on bringing systems like AhaSlides/Mentimeter to their schools, they did have some realistic concerns and varied experiences of teachers in adopting such technology to conventional teaching practice. Such challenges might affect SRS-mediated classroom interactions and learning. For example, AhaSlides/Mentimeter were seen as reasonably easy to use, but some brief technical problems (e.g. system lags, answer submission difficulties) emerged a few times.

Another level of complexity was introduced when the QR code feature giving users the option of accessing the content on their mobile phones stopped working in the middle of the presentations. This technical problem interrupted the interactive flow of the presentation; instead of scanning the QR code with their phones, participants were forced to manually type in the information. However, teachers also said that any possible problems with the interface could be quickly fixed by pressing the back and forward buttons to move back and forth to the question they were addressing. In general, there were very few problems with the system, and they did not greatly affect user satisfaction.

The survey findings supported the participants' narrative, with 81.3% (Figure 13) strongly agreeing that they found no technical difficulty using AhaSlides/Mentimeter and 93.8% (Figure 14) confirming that AhaSlides/Mentimeter was easy to access, powerful and flexible.

Figure 13

Participants' perceptions of technical ease of use of AhaSlides and Mentimeter

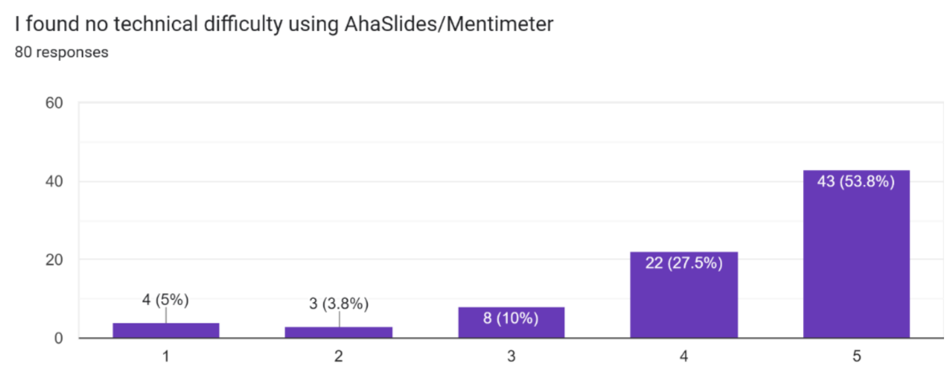
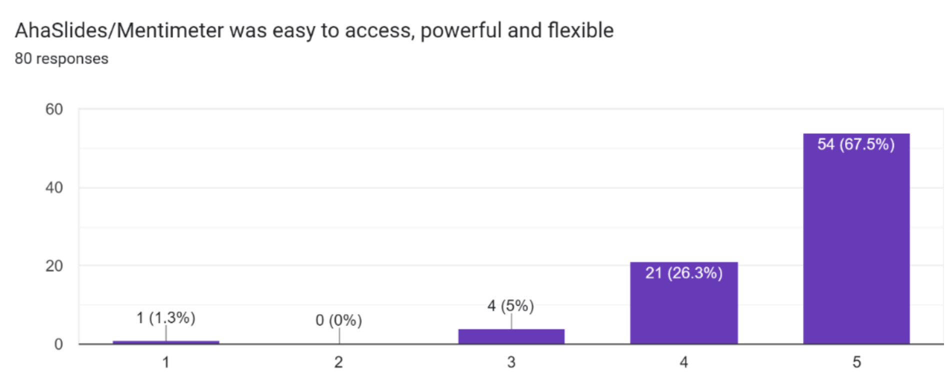


Figure 14

Perceived accessibility and flexibility of AhaSlides and Mentimeter



However, teachers have also conceded that several factors may come into play to disrupt the integration process of SRS technology. The ability to integrate this technology differs from one school to another because not all learning institutions have a sufficient number of iPads. Sometimes, it is vital to have an advanced subscription to ensure access to such functionalities for the students. Furthermore, the feasibility of using iPads for the students may be a concern and is viewed as difficult for young students, such as primary students. The challenge of teaching young pupils how to use iPads, along with potential distractions, means these tools can be disruptive to education.

In addition, some of the respondents have found verbal communication to be simpler than written communication, especially with the English language, because Arabic is the students first language:

> Personally, I have experienced occasions when it became difficult for me to express my thoughts clearly in writing. This made it difficult for me to participate in the discussions in class.

Other participants suggested that it is helpful to combine a variety of teaching tools and resources in different subjects to ensure student engagement. When lessons make use of various resources such as AhaSlides and Kahoot games, among other interactive resources, a teacher will avoid monotony, which can lead to learners' boredom and disengagement:

> Depending completely on just one platform would disengage students as repetition leads to decreased excitement and motivation… Therefore, it is important to vary resources in order to maintain student attention and involvement in the learning experience. Introducing different tools creates a very positive and dynamic environment for learning.

A few also commented that they prefer the traditional way of learning in a face-to-face setting because the lecturers will encourage the students to express their understanding vocally and raise their hands to allow them to participate. They also feel that overuse of SRSs in every classroom can be counterproductive, limiting the discussion or interaction among students and creating dependency on technology.

Therefore, they do not advocate for the routine use of AhaSlides in every class. However, incorporating occasional longer AhaSlides sessions to assess students' understanding and stimulate discussion before mid-term or end-of-term evaluations could be beneficial.

The integration of SRSs was also challenged by teachers having a distinct technology system for assessment and student engagement. However, without this established system, they would certainly opt to use AhaSlides as a viable alternative.

In general, the participants felt that implementing AhaSlides/Mentimeter had increased both their confidence and inclination to make use of the SRS technology in the course they were attending. They also felt more inclined to use it in their schools with their students.

Discussion

The findings from this research had two implications: the impact of vicarious reinforcement on student teachers' beliefs about the use of SRSs and the role SRSs played in their own learning experiences. Based on the positive experiences of learning with AhaSlides and Mentimeter, vicarious reinforcement was one of the influential factors that molded teachers' attitudes and teaching practices concerning SRSs use in the classroom.

Participants observed how they and their colleagues were able to effectively use the technology of SRSs and its impact on students to engage and participate. Rather than simply informing their opinion, the increase in engagement was a vicarious reinforcement that changed the teachers’ views about both SRS adoption and the technology itself, softening their resistance to it. As a result, and consistent with Bandura's social learning theory (1977), following extended use of AhaSlides and Mentimeter over a period of 13 weeks, along with peer modelling and shared success, the teachers were more willing to consider new teaching practices.

Participants indicated that these tools were quite effective at keeping students on task and bringing them back to engagement with content. From an interpretive lens, the affordances of AhaSlides and Mentimeter appeared to support cognitive load management and redirect learner attention within the classroom. The platforms also contributed to increasing the thirst for knowledge and to an inclusive atmosphere for learning where the students could express their views without being judged. This interpretation aligns with previous studies which have indicated that interactive technologies increase engagement and motivation (C. Liu et al., 2019).

Participants also gave AhaSlides and Mentimeter better ratings than other platforms, such as Kahoot, as they remained the most effective at holding learners' attention. They appreciated the flexibility of these applications to pose multiple question types in one poll, which meets various teaching/learning needs.

Another key result concerned students' attendance and presence. The implementation of AhaSlides and Mentimeter, with attendance procedures that were focused on contribution, motivated the students to take part actively in the class, which is consistent with the results of Hunsu, Adesope, and Bayly (2016) , who carried out a meta-analysis and found data suggesting that class attendance was an important learning-related outcome when response tools were used as part of class participation structures.

Several participants mentioned that they intended to adapt these tools for use in their own teaching, indicating that they saw potential pedagogical application beyond the confines of the research study and in line with findings reported by C. Liu et al. (2019). The findings for instructional leadership imply that leaders must play a role in planning, developing and sustaining on-going professional learning that is embedded in practice, so teachers can learn to observe, practice and reflect on the use of technology in real classrooms.

Furthermore, SRS-based integration may address the problem of engagement and focus in virtual classroom. With predictable times for feedback and interaction, AhaSlides and Mentimeter enhanced students' feeling of purpose and inspired them to attend more sessions and continue paying attention. These findings suggest that features available within SRSs can act as facilitators for engagement (rather than just technological necessities), highlighting the importance of pedagogical design.

Overall, the respondents reported positive experiences and attitudes with Mentimter and AhaSlides, but they did anticipate some challenges in instrumenting the tools. These included infrequent technical problems (such as delayed responses or disruptions in QR codes), and questions were raised regarding how applicable the system is in resource-poor schools or with very young students. These limitations are in line with prior research reporting first-order barriers to technology integration (Kocak, 2022). Importantly, all of these reflect the contextual character of SRS acceptance and suggest that a balanced adoption is imperative.

The collaborative inquiry design facilitated depth of findings as it captured the evolution of participants' understandings and experiences of employing SRSs. Employing surveys and interviews, respondents described a variety of advantages and tensions or constraints in relation to the use of SRSs.

Finally, this work points to another mode of PD, one that is centered on vicarious reinforcement and extended, practice-based learning. Nevertheless, the particularity of the context and the dual role of the researcher as teacher and instructor may limit the possibilities of generalization, especially in terms of transfer to other institutions. It would be beneficial for further studies to analyse how these methods function in different environments and leadership systems in order to better support these findings.

Conclusion

The findings of this research indicate that AhaSlides and Mentimeter can promote inclusiveness and increase student participation in university classrooms, especially with those of active learning lectures. The quantitative and qualitative results show that the introduction of SRS could mitigate problems related to early adoption of technology. Improved teacher attitudes and high engagement indicate that vicarious reinforcement has potential to decrease resistance towards technology integration, pointing to the need for prolonged, "experiential" exposure as opposed to one-shot workshops for successful adoption.

The mixed-methods collaborative inquiry design was appropriate for the study purposes and the complexity of the educational context. The quantitative data showed that participants were highly engaged and motivated, while qualitative data from reflective journals and focus groups suggested changes in teachers' beliefs about technology use. Taken together, these findings suggest that vicarious reinforcement was successful in overcoming both first-order (technical) and second-order (attitudinal) barriers to change by fostering technical competence through observation of peer success and nurturance of sustained enactment.

The study was further enhanced by the collaborative nature of the inquiry, which brought student teachers and researchers as equal partners in the investigation. This engagement in reflection and shared decision-making allowed members to critically assess SRS use, while peer demonstration and mutual support emerged as key mechanisms supporting technology adoption.

Collectively, these results highlight the importance of professional development models that supplement, as opposed to supplant, traditional methods of training. Overcoming extrinsic and intrinsic barriers to technology implementation can potentially increase teachers' motivation and intention to use digital tools in learning environments. Implementing this model in teacher education and professional development programs could provide authentic and inclusive technology integration opportunities for teachers at all levels of experience, potentially advancing a more enduring path of educational reform.

Study's Contribution and Implications for Future Research

The findings of this study have important implications for SRS use in both K–12 and higher education institutions. The research strengthens existing perceptions of SRS as effective instructional tools by demonstrating the positive impact of AhaSlides and Mentimeter on student participation, inclusiveness, and learning outcomes. These findings provide instructors across educational levels with practical insights into how SRS can be used to design more engaging and inclusive learning environments.

The study also highlights the importance of targeted professional development, ongoing institutional support, and the development of teachers' technical self-efficacy to enable meaningful technology integration. Vicarious reinforcement emerged as one effective strategy for supporting teacher adoption of SRS. Educational leaders and teacher educators are therefore encouraged to test this model further and to explore additional strategies that address teachers' hesitation or resistance to technology use. Integrating such approaches into teacher education programs in higher education may support the sustained development of innovative pedagogical practices.

Future research could build on these findings by extending the concept of vicarious experience in technology integration. Longitudinal studies examining changes in teachers' attitudes and instructional practices over time would offer deeper insight into the lasting effects of observing peers' successful technology use. Moreover, investigating vicarious experiences across diverse educational contexts and digital tools could inform the design of professional development programs that more effectively reduce resistance and promote sustained technology adoption.

Abbreviations

HE: Higher Education; HEI: Higher Education Institutions; LMS: Learning Management System; PCA: Principal Component Analysis; PD: Professional Development; SRS: Student Response System; SRSs: Student Response Systems; UAE: United Arab Emirates.

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Author's contributions

RH conceptualised the study, led the research design, and coordinated data collection. PF contributed to methodological refinement, analysis, and manuscript development. All authors participated in data interpretation, drafting, and revising the manuscript and approved the final version.

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Availability of data and materials
The datasets generated and analysed during the current study are not publicly available due to institutional ethical restrictions and participant confidentiality agreements; however, they are available from the corresponding author upon reasonable request.

Declarations

Competing interests
The authors declare that they have no competing interests.

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