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Exploring quality attributes of smart classrooms from the perspectives of academics

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Abstract

The purpose of this study is to explore attributes that influence the quality of smart classrooms from the perspective of higher education teachers. Relying on a purposive sample of 31 academicians from Gulf Cooperation Council (GCC) countries, the study identifies themes related to quality attributes of technology platforms and social interactions. These attributes are user security, educational intelligence, technology accessibility, system diversity, system interconnectivity, system simplicity, system sensitivity, system adaptability and platform affordability. The study identifies management procedures, educational policies, and administrative practices that enact, engineer, enable, and enhance these attributes in smart classrooms. The findings also highlight strategy-oriented planning and cause-driven transformation as the main smart classroom contexts influencing the quality of education among interviewees. With insights from the interviews, this article discusses some theoretical and practical implications of the study, research limitations, and potential future research directions.

Keywords Smart classrooms · Higher education teachers · Quality · Change · Technological dimensions · Social dimensions · Smart learning

1 Introduction

According to the World Bank (2020), the impact of technology adoption on student performance remains mixed at best. However, the Coronavirus Disease 2019 (COVID-19) pandemic shifts the debate on technology adoption from being a question of *if* to a question on *how* use influences performance (World Bank, 2020). The pandemic sparked an impulse towards a greater technology use and adoption of new platforms and digital technologies (Saura et al., 2022). Thus, there are pressing needs

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to re-imagine education to respond effectively to the disruption caused by the web and associated technologies (AlMalki & Durugbo, 2023; Yeh & Walter, 2016) and to a post-COVID era (World Bank, 2020). Reports suggesting that educational systems are rarely working well necessitate a need for innovation in education (World Bank, 2019; Johnes et al., 2017) with research noting that students are not gaining the skills needed for the 21st professional careers (Trucano, 2017). Policymakers argue that innovations aimed at reimagining the role of education could drive substantial welfare gains (U.S. Department of Education, 2017). Significantly, some practitioners note concerns over efficiency and productivity of educational expenditures and urge that technology-based solutions to improving and re-imagining education lie in technological innovations (OECD, 2016; Flavin & Quintero, 2018) such as smart classrooms that integrate smart devices and technologies (e.g., sensors and microcontrollers) to improve teaching and learning processes (Chamba-Eras et al., 2018).

In the knowledge age, integrating technology into the classroom increasingly emerges as an approach that can help to improve learners' higher-order thinking to suit the demands of the 21st century (Di, Danxia, & Chun, 2019). Consequently, smart classrooms are expected to gain more popularity, and emphasis should be on ensuring schools adopt design criteria that guarantee quality (Alfoudari et al., 2021; Dong, et al., 2019). Maintaining high quality levels and standards ensures educational institutions provide safe learning environments, ensure comfortable conditions for study, and develop relevant skills for instructors and learners (Songkram, 2017; Abdellatif, 2019). Although, the need to ensure quality in part explains foci on examining and establishing effective smart learning configuration and design (Dong et al., 2019; Wu, 2016), an analysis of the literature suggests limited coverage on research dedicated to the quality attributes of smart classrooms – as opposed to smart classrooms being attributes for the quality of education. Such paucity is the motivation for this research.

The aim of this study is to explore attributes that influence the quality of smart classrooms from the perspective of higher education teachers. The quality of education is not a concept that is inherently related to commercial dimensions (Vlachopoulos, 2016). Rather, research argues that technology and human relations contribute to the success of learning environments (Lee et al., 2020).

The originality of this study is to address the emerging gap on quality of smart classrooms. Current research notes the central role that technological factor in influencing smart classrooms adoption (Selim et al., 2020; Lu et al., 2021; Kuppusamy, 2020). Smart classrooms are technology-rich learning environments with information and communication technologies (ICTs) tools, learning resources, and interaction support that facilitate data storage, collection, computation, and analysis for optimal pedagogical decisions (Lu et al., 2021). Central to the concept of smart classrooms is the use of internet systems, sensors, cameras, and other computational devices surveilling educational participants to facilitate educational processes. Smart classrooms also involve an elaborate lattice of information networks that share, merge, and create data and data profiles (Kwet & Prinsloo, 2020). Apart from technology features, IT knowledge is crucial to IT adoption. Successful use of technology innovations significantly depends on employees having sufficient skills and knowledge to use them (Selim et al., 2020). A central feature of smart classroom is the advanced implementation of technology to enhance educational outcomes.

There are also studies on smart classrooms that emphasize the essence of social factors. Teachers must dynamically adjust teaching strategies to suit learners' performance and acceptance levels (Dai et al., 2021; Cheung & Wang, 2021). The social dimension applies since improving learning outcomes inherently concerns ensuring affective and cognitive engagement and encounters with authentic tasks with real-life applications. Consequently, aspects vital to the social dimension such as motivation, sentiments, and autonomy arise even when integrating technology (Cheung & Wang, 2021). Smart classrooms are social spaces in which interactive exchanges occur between teachers and learners. The social space dimension of smart classrooms is a pertinent factor to consider in suggesting improvements.

While much has been written about smart classrooms, the literature has primarily focused on technological factors or social factors that can improve teaching and learning outcomes with limited coverage on the interaction of the factors and quality of education. Past studies on smart classroom environments primarily focus on providing signposts on how to transform teaching and learning before accommodating new technologies. However, gaps remain as there lacks a holistic model applicable in quality considerations for smart classroom learning environments. Such a model is warranted as the popularity of such environments increase. The lack of past scholarly work on these dimensions presents a research gap that this study seeks to address. Achieving this objective will be possible if findings enlighten educators and policymakers on the technological and social dimensions of quality applicable in deploying smart classrooms that meet high quality standards. This has the potential for a multiplier effect throughout the education sector with implications for national and regional competitiveness. This study aligns with arguments proposing that the cornerstone of any effective 21st century learning framework demands transformative strategies that integrate the smart classrooms concept (Al-Hunaiyyan et al., 2017). Consequently, the expectation is a focus on quality could aid in identifying policy-making measures to advance smart classroom adoption. Promoting quality in education remains a central issue worldwide (Paraschivescu & Savga, 2016) and this study responds to a unique need to assess the quality attributes of smart classrooms.

The study employs purposive sampling of higher education teachers to gain a deep understanding about quality aspects of smart classrooms. Using the interviews with the sampled participants, the study presents insights relevant for smart learning (i.e., learning via integrated use of technology) initiatives targeted at enhancing the quality of smart classrooms. This study shows that technological and social aspects interact with quality contexts to shape the quality of smart classrooms. Enhancing the quality of teaching and learning in smart classroom requires joint evaluations of different dimensions of these interlinked aspects. The rationale for this research is that insights on social and technological dimensions in smart classrooms can assist in better understanding changes necessary to enhance quality of smart learning. Although, formal learning remains in physical environments, smart classrooms for teaching and learning are a growing trend in society (Liu et al., 2017), and there is a need to shed light on the nature of quality that contributes to realizing and enhancing smart classroom potential.

This study is necessary because effective adoption of smart classrooms will depend on the readiness of educational institutions. Smart classrooms are still a developing phenomenon and existing gaps in literature serve as basis for improving the quality of smart education. The reminder of the article details the literature review including the

research framework, methodology, findings and a discussion of the research implications followed by conclusions and suggestions for future research directions.

2 Literature review

Smart classrooms emerge from technological infusion and diffusion in educational to provide learning support to students (Marcellus & Ghrayeb, 2015; Taleb & Hassanzadehb, 2015). Unlike conventional classrooms, a smart classroom contains a range of adaptive interfaces, such as tablets, video recorders, digital wristwatches, and smart phones as part of the education delivery system. Collectively, these features make the smart classroom learning environment highly integrated via technology tools (Al-Sharhan, 2016). In the view of authors such as Gros (2016), a standard smart classroom design needs to consider prevailing socio-cultural features, the context, and cultural resources. Gros further argues that in addition to focus on enhancing learning processes, smart classroom design should emphasize individualized adaptation of educational services. To achieve this goal, users must be included in the design making process and offered continuous support.

The rest of this section present a background on smart classrooms in education, the concept of quality in education, and a socio-technological perspective on quality for smart classrooms that is linked to the purpose of the study.

2.1 Smart classrooms in education: A background

Evidence from recent years show a growing trend in classroom reconstruction based on the attributes of smart applications, smart technology, and smart management (Song et al., 2014). Among the technologies gaining popularity in the education sector include technologically advanced devices and intelligent systems, mobile and web applications, connectivity, data analysis and decision support, cybersecurity, storage and backup, and content management systems (Li-Shing et al., 2019; Cebrián et al., 2020; Zhang et al., 2022). Underpinning this shift are proposals for the creation of a physical space that is richly interwoven with actuators, sensors, displays, and computational elements that are embedded seamlessly and connected through a continuous network (Jun & Hong, 2014; Liu et al., 2017; Kwet & Prinsloo, 2020). Smart classrooms are part of the shift to ensure learning is student-centered and reduce the teachers' contribution to enable learners to give more attention to the curriculum (Shahkarami et al., 2015). Thus, authors argue that smart learning is an important part of a learning society (Liu et al., 2017). There have been varied efforts to define smart classrooms, and a common feature is their emphasis on smart devices and intelligent technologies (Bognar et al., 2019). This study adopts the definition by Song et al. (2014) for a smart classroom as a kind of classroom with smart application services, hardware, and software to enable teachers to teach using varied forms of media. Authors such as Nishantha et al. (2009) previously advance this perspective and argue that smart classrooms can revolutionize educational paradigms and facilitate the delivery of top-quality educational programs globally.

Various authors highlight different perspectives for characterizing the uniqueness of smart classrooms. According to Liu et al. (2017) and Li et al. (2019), new perspectives towards learning approaches are necessary when dealing with smart classrooms due to flexibility offered beyond the conventional technology-enhanced classrooms. Dai (2019) identifies convenience and deep interactions, while Di et al. (2019) propose smart classrooms as useful for facilitating higher-order thinking. Other perspectives include the need to focus on the social and environmental constructs (Papadakis et al., 2019), and ease of access to required content via interactions with technology (Temdee, 2019). The diverse characterization prompts this study to approach smart classrooms in terms of their intelligent spaces meant to enhance learning, convenience in accessing content, presentation, interactions, and classroom management. This characterization represents an inclusive view of the smart classroom concept with considerations for potential applications in blended, flipped, and virtual classrooms.

Literature suggests various social and technological challenges of smart classrooms. Social challenges tend to revolve around three main considerations: personalization, engagement, and interactivity (Alfoudari et al., 2021). Personalization, i.e., supporting personalized features, ensures smart classrooms remain convenient, healthy, and safe (Zheng et al., 2019; Choi & Suk, 2016; Vasanthapriyan & Randima, 2019; Sevindik, 2010; Lee, 2015; Uzelac et al., 2015; Ouf et al., 2016). Challenges also arise in personalizing the learning environment to promote learning attitudes and motivation (Munawar et al., 2018; Tlili et al., 2019; Aguilar et al., 2017). Success of smart classrooms also depends on personalization of teaching methods by educators (Miraoui, 2018; Godlewska et al., 2019).

Engagement is the next challenge that concerns attracting and sustaining interests in learning content, instructors, and peers (Gupta et al., 2019; Timms, 2016; Alghamdi & Altameem, 2019; Terziyan et al., 2014; Pingxiao, 2017; Dutta et al., 2018; Li et al., 2019; Tissenbaum & Slotta, 2019). Difficulties in achieving engagement in smart classrooms shifts focus to informal learning (Krummheuer et al., 2018), unrestricted learning projects (Said & Albagory, 2016), active learning (Saraubon, 2019), and engagement in exploration works (Godlewska et al., 2019). Smart classrooms develop in a school context but the uniqueness of the smart classroom concept lies in technological advancements and managerial commitment to integrate software applications, intelligent systems, decision support storage, and technological platforms in a richly interwoven and networked physical space (Li-Shing et al., 2019; Cebrián et al., 2020).

Closely related is the third challenge of interactivity (Benakli et al. 2016; Cheong and Koh 2018), where the main difficulties lie in the design phase. Complications often arise in creating learning environments that facilitate seamless exchanges (Al-Qirim, 2011), stimulate learning (Kumara et al., 2015), promote engagement (Cho et al., 2012), suit varied learning patterns of each learner (Rajesh & Reena, 2015), and afford time to both students and teachers to contribute adequately (Jo & Lim, 2015). Technological issues arise in developing designs that fit the demands of integrated intelligent systems (Zheng et al., 2019; Pirahandeh & Kim 2015), learning environments (Benakli et al., 2016; Cheong & Koh, 2018), system models and ontologies (Huang et al., 2019), social media and mobile applications (Dos Santos, 2019; Suo et al., 2009), and analytic tools and analysis (Di et al., 2019; Wang et al., 2019). Table 1 summarizes these challenges.

Table 1 Smart classroom challenges

Social Challenges	Technological Challenges
• Personalization of ○ external factors ○ learning attitudes ○ teaching methods • Engagements with ○ Learning content ○ Instructors ○ Peers • Interactivity for ○ Pursuit of experience-based investigations of joyful learning experiences ○ Experience exchanges ○ Changing dynamics of student learning patterns ○ Student and teacher participation ○ Teacher and student aptitudes ○ Student talk and teacher lecture ratios	• Designing learning environments • Integrating intelligent systems • Proposing system models and ontologies • Applying analytic tools and analysis • Supporting mobile technology and social media applications

2.2 Quality in education

Over time, the concept of quality has fascinated academics. Seminal authors like Juran (1999), Zeithaml, Parasuraman, and Berry (1990), and Caruana (2002) consider quality as meaning features of products that meet the desired needs of users leading to desired user satisfaction and freedom from errors likely to necessitate rework. Thus, achieving higher quality involves effort, investment and strategy with attention to the attributes that constitute quality. Describing quality in education is challenging because quality tends to be experienced rather than defined (Sahney, Banwet, & Karunes, 2006). Nonetheless, research offers multiple dimensions to determine the quality of education and create appropriate value propositions (Haseena & Mohammed, 2015). Akareem and Hossain (2016) suggest that the main dimensions of quality are faculty credentials, quality of students, administrative supports, and academic features. However, the choice of dimensions depends on the expectations and interests of the concerned individuals (Cheng & Tam, 1997). The lacking of consensus provides opportunities for studies to establish the most vital dimension in ensuring quality in education.

Various studies consider the concept of quality in educational settings. For instance, in their study seeking to examine whether one's demographic and background influences perceptions regarding higher education, Akareem and Hossain (2016) found that the status of learners for scholarship, parents' education, extracurricular activities, previous result, age, and the university where they study influences their perception about quality of higher education. Jun and Hong (2014) aimed to establish quality standards based on existing quality standards in e-learning, while Shahkarami et al. (2015) investigated the effect of educational technology in the quality and learning of physical education and found that educational technology improved the quality of teaching. Assuming a more sophisticated stand on quality through total quality management (TQM), Sahney et al. (2006) found quality to be the primary determining factor for long-term competitive success of educational organizations. TQM relates

to an organisational culture and continuous process of evaluation with the purpose of elevating the quality levels of organization by engaging organizational members to achieve the organization's long-term goals (Perdomo-Ortiz et al., 2006; Johnson & Clark, 2008; Oakland, 2003; Sallis, 2014). In their study, Milenkovska and Novkovska (2019) showed that TQM can be achieved using business process modeling for higher education. Similarly, Aziz, Mahmood, and Bano (2018) found that TQM assumes a central role in improving the quality of higher educational institutions and offers a unique avenue for attaining quality. Gligorić et al. (2012) employed different parameters to assess the quality of lectures after applying Internet of Things in smart classrooms. Cheng and Tam (1997) sought to develop a multi-model of quality applicable in education to facilitate practice, support policy making, and develop policy agenda. This study adds to the existing research by introducing a new perspective termed the total quality management for education (TQM4E) - a management philosophy applying TQM to an educational context.

2.3 Quality for smart classrooms: A socio-technological perspective

Forecasts project exponential growth in the adoption of smart classrooms for the coming years (Uskov et al., 2015) due to the emergence of smart systems, applications and technologies that provide unprecedented opportunities for quality teaching and learning (Oubibi et al., 2022). In addition, there are credible signs that smart classrooms have the potential to revolutionize schooling. However, realizing high-quality smart classrooms would require insights on their disruptive nature and attributes (Pishva & Nishantha, 2008). For instance, Garrison (2009) notes that improving the quality of smart classrooms requires solving technological issues hindering learning and fostering social relations for enhanced value creation. Importantly, the quality of smart classrooms depends on commitments to technology platforms and social interactions (Pishva, 2007). Thus, the solution to ensuring quality lies in fine-tuning technology platforms and social interactions.

Other lines of reasoning argue that learning analytics of a smart classroom improves teaching processes since the intelligent environment observes student responses and helps in decision making to improve the quality of instruction and students' performance (Gligorić et al., 2012; Gligoric et al., 2015; Aguilar et al., 2018; Uskov et al., 2019). Nevertheless, the main quality factor remains the efficiency and effectiveness of digital devices and learning software incorporated with sensor networks to track smart classroom processes. The other quality factor is the reliability of data gathering and feedback to inform decision making for superior and faster learning (Cebrián et al., 2020). Moreover, the usability and flexibility of smart technology is also a crucial quality factor. Imperatives exist for the technology to be adaptable to different pedagogical aspects and respond to specific educational needs, rather than remaining merely innovative solutions unconnected to teaching and learning. Another aspect of the quality is the range of environmental conditions such as air quality control, lighting, and acoustics that affect learners directly in terms of their comfort, well-being, and as a consequence, the quality of learning (Cebrián et al., 2020). Figure 1 summarizes the preliminary model showing the interaction

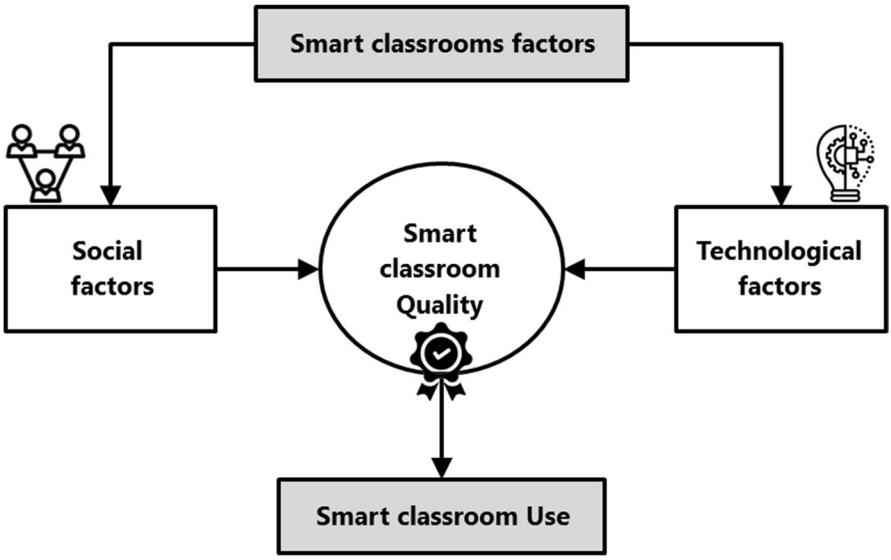

Fig. 1 Preliminary model for analyzing smart classroom quality

between the investigated smart classroom factors. The figure conceptualizes smart classroom quality as dependent on technological and social factors and how quality subsequently shapes smart classroom use. Technological factors are vital because interactive devices are at the center of smart classrooms (Al-Sharhan, 2016), and the interactivity attributable to technology is a significant quality issue in smart classroom contexts (Cebrián et al., 2020). Apart from technology, the quality of smart classrooms also depends significantly on how the classroom spaces and pedagogies are socially enhanced (Cebrián et al., 2020). Social factors such as support perceptions, motivation, and engagement have a considerable impact on cognitive engagement that takes place in smart classrooms.

Motivated by these different concerns in literature, as summarized by Fig. 1, this study seeks to investigate the perspective of higher education teachers on attributes that influence the quality of smart classrooms. The research questions guiding the study are as follows:

RQ1. What are the main quality attributes of smart classrooms associated with social and technological factors from the perspective of academic staff?
RQ2. How can policymakers enhance the quality of smart classrooms?

Motivated by these research question, the primary objective of this research is to examine what academics consider important for ensuring quality of the design spaces, configurations, and environments of smart classrooms. Based on these research questions, the next section details the methodology regarding adopted research design, philosophy, data analysis, data collection and thematic analysis.

3 Research methodology

This study adopts an exploratory approach (Gray, 2013) because the primary concern for the research is to shed light on the quality attributes of smart classrooms, and exploratory studies support emerging evidence to acquire meaningful data that explain phenomena. Exploratory research attempts to discover something new about a research topic and helps develop a rich understanding of research questions and findings (Lavigne et al., 2020; Elman et al., 2020). Multiple studies also adopt the exploratory approach when tackling topics related to smart classrooms because of the novelty or new expectations involved (Zhang et al., 2022; Jia, 2022; Petchamé et al., 2021). The approach assists the researcher to understand the forces that facilitate the occurrence of the phenomena observed in the study. The exploratory approach is also suited to studies with "what" and "how" questions (Strydom, 2013) and addresses the questions posed by **RQ1 and RQ2.** Furthermore, exploratory studies enable the acquisition of valuable information to understand and explore the causal relationship between variables (Popova et al., 2018). Since smart classrooms are still a developing concept, there are knowledge gaps on the workings of the concept and studies on how to improve smart classrooms are bound to be exploratory in nature.

3.1 Philosophy

Constructivism guides the research and supports the use of prior experiences and background knowledge to construct new knowledge regarding the phenomena under study (Ultanir, 2012). The rationale behind this choice is that it enables the researcher to derive in-depth and meaningful understanding of the implications of smart classrooms on the students' learning by deriving new insights that enrich the already existing knowledge base regarding the phenomena (Panasuk & Lewis, 2012). The constructivist theory is based on the premise that the meaning constructed refers to the law and nature of things and the internal connection between them. The focus of learning is to have a deep understanding of the laws, nature, and internal relationships of things. Thus, the realization of meaning from construction of knowledge is the ultimate goal of the learning process (Zhang, 2022). A central proposition of constructivism is social interaction theory emphasizing that people's learning and development occur when they interact with others. In this view, knowledge is constructed in specific social and cultural contexts with the assistance of others and using appropriate materials to construct meaning (Xu, 2022). Such implied cognitive development on a topic is intertwined with the learning process in which the learner constructs new knowledge.

3.2 Data collection

This study collects data on the perspective of higher education teachers as subject matter experts on smart classrooms. Subject matter experts are individuals with prior familiarity, knowledge and experience on a subject of interest (Baran & Jones, 2016) and their involvement facilitates the constructivism epistemology that guides

this study. The experts have practical experience with the application of smart classrooms in teaching. Purposive sampling is employed and involved first identifying those who can help develop a richer understanding about smart classrooms (Nishishiba et al., 2014). Rather than aggregate opinions from a sample from the general population, the research questions would be better answered by soliciting expert opinions (Stufflebeam, 1985).

In selecting participants, the first step was to ascertain the appropriate informants who had practical encounters with the smart classroom concept. For this stage, we held pre-consultations with educational technology instructors from three higher education institutions, and these instructors recommended a sample of academic administrators involved in implementing smart classrooms. We then sampled heads of departments, professors, assistant professors, and deans and administrators involved in smart classrooms implementation, and serving in higher education institutions in GCC countries, as the study's informants. Thus, the research excludes academic staff members without hands-on experience in managing smart classroom settings and those not in GCC countries. The higher education institutions selected from the study were derived from list of institutions adopting the smart classroom concept in different GCC countries based on initial contact with instructors within technology departments.

Upon identification of the participants, the study commenced formal communication to request confirmation for participation and a signed informed consent form. Thereafter, follow up communication served as an avenue to arrange for the interviews. Semi-structured interviews offer deep, rich and valuable data sets from a focused yet conversational two-way interviewer-interviewee communication, and serves as the preferred choice for data collection due to support for blending both closed and open-ended questions with follow up "why" or "how" queries to gain in-depth understanding of the participants' perceptions. Due to COVID-19, all interviews were conducted virtually via phone or video calls (via WhatsApp, Zoom and Skype instant messaging services). Using an interview protocol (see Appendix) developed from the conceptual framing, the semi-structured interview with participants lasted an average of 39 minutes. All interviews involve audio recordings with the permission of participants and aid in preserving accuracy during the retrieval of responses, allowing interviewers to concentrate fully on the interview content and verbal prompts (Adams, 2015).

In this study, 31 interviews were conducted with professors from different universities across GCC countries. The data for this study are the from interviewees who gave their consent to participate, and contact was mainly via email. Table 2 provides an overview of participants' positions, departments, working experience, and duration of each interview.

As Table 2 shows, twenty-two interviewees served either as full professors, assistant professors, or associate professors. Others presented themselves as chairpersons (2), administrator of learning management systems (LMS) and Web Master (1), teacher of educational technology (1), co-teacher (1), dean of the school of e-education (1), head of e-learning (1), and head of development department (1). One interviewee serves as a chairman and full professor in a department of Management Information Systems (MIS), and average experience of interviewees was 15 years, ranging from 3 to 36 years.

Table 2 Overview of interviewees' details

Code	Position	Department	Experience	Duration
Int_1	Associate Professor	Management & Marketing Department	20 Years	39 Minutes
Int_2	Assistant Professor	Curriculum & Teaching Method Department, Specialty in Education Technology	10 Years	79 Minutes
Int_3	Assistant Professor	Computing Department	11 Years	46 Minutes
Int_4	Administrator of LMS And Web Master	Department of E-learning	5 Years	34 Minutes
Int_5	Assistant Professor	Gifted Education	8 Years	32 Minutes
Int_6	Assistant Professor	Instructional Technology Department	5 Years	37 Minutes
Int_7	Teacher of Educational Technology	Education Technology Department	27 Years	38 Minutes
Int_8	Co-teacher	Computer and Communication	15 Years	25 Minutes
Int_9	Professor	Curricula and Teaching Method & E-learning	20 Years	59 Minutes
Int_10	Associate Professor	Sociology Department	18 Years	60 Minutes
Int_11	Assistant Professor	Instructional Technology Department	4 Years	35 Minutes
Int_12	Assistant Professor	Instructional Technology Department	4 Years	61 Minutes
Int_13	Assistant Professor	Human Resource Management	3 Years	24 Minutes
Int_14	Assistant Professor	Instructional Technology Department	3 Years	52 Minutes
Int_15	Associate Professor	Management	10 Years	55 Minutes
Int_16	Dean of the School of E-Education.	Curriculum & Instructional Design, Major in Distance Learning	25 Years	45 Minutes
Int_17	Head of E-learning	Business and Science	36 Years	45 Minutes
Int_18	Assistant Professor	Instructional Technology Department	28 Years	27 Minutes
Int_19	Associate professor	Instructional Technology Department, Faculty of Basic Education.	36 Years	49 Minutes
Int_20	Full Professor	Media Department	17 Years	27 Minutes
Int_21	Full Professor	Department of Marketing	20 Years	50 Minutes
Int_22	Associate Professor	Human Resource Management	8 Years	36 Minutes
Int_23	Associate Professor	Management Information Systems	12 Years	40 Minutes
Int_24	Assistant Professor	Education Technology Department	11 Years	60 Minutes
Int_25	Chairman	Multi-media Science Department	15 Years	23 Minutes

Table 2 (continued)

Code	Position	Department	Experience	Duration
Int_26	Chairman	Social Science Department	30 Years	20 Minutes
Int_27	Assistant professor	College of Business	5 Years	18 Minutes
Int_28	Assistant professor	Curricula and Teaching Methods, Faculty of Education	4 Years	46 Minutes
Int_29	Chairman & Full professor	Department of Management Information Systems	28 Years	40 Minutes
Int_30	Assistant Professor	Business Department	5 Years	22 Minutes
Int_31	Head of Development Department	IT, Development Department	11 Years	28 Minutes

3.3 Data analysis

Data analysis for the study involves thematic analysis (Vaismoradi & Snelgrove, 2019) using ATLAS.ti software. This approach identifies, organizes, describes and reports important or interesting patterns or themes prevalent in the data set for informed insights regarding the phenomena under study (Friese, 2019). Using analytic examination of the responses from the study participants, researchers analyze data sets into smaller codes that unite the related ideas and meanings accrued from studying the phenomena. Since thematic analysis is not attached to a specific epistemological or theoretical viewpoint (Maguire & Delahunt, 2017), it is flexible and appropriate to capture the diversity of work in learning and teaching.

For the analysis, the study applies a systematic framework with six stages that include becoming familiar with the data, generating initial codes, searching for themes, reviewing themes, defining themes, and articulating the themes in a report (Maguire & Delahunt, 2017). The reliability and validity of developed themes (Herzog et al., 2019), follow the six stages and fulfilled by, the author, co-authors and a group of five co-opted independent researchers as subject matter experts. The author and first co-author contributed to the six stages. The second co-author reviewed the documents and refined proposed themes. The independent researchers assisted in reviewing and comparing the developed themes, in line with suggestions by Alhojailan (2012). The next section presents the findings following the thematic analysis to identify and articulate the patterns present in the data for insights regarding the phenomena under study.

3.4 Reliability and validity of the study

For verification purposes, the study involved preparing detailed notes on interviews. Additionally, the research was iterative and moved back and forth to ensure the all the steps are congruent. During study, long engagement in interviews and triangulation of data sources were considered for credibility. Following the six analysis steps produced 59 subthemes that subsequently generated 9 themes for the articulation step. Intercoder-reliability based on percentage agreement is 95.1% (59/62), and results in three dropped concepts that relate to different terminologies and disruptive smart classroom attributes.

The five independent researchers reviewed the documents of the established themes, and the purposive sampling of academics from different GCC countries seeks to improve the external validity of the research. The themes were also presented and discussed at two events: a PhD workshop and a research day event using a poster summarizing the research findings.

4 Findings

This section presents the findings on quality attributes for smart classrooms due to technological aspects and social interactions.

4.1 Quality attributes of technology platforms

In relation to the quality attributes of technology platforms, the interview data indicates three main themes i.e., technical system support for security, flexible analytics modules for intelligence, and integrated mobile application for accessibility. As shown by Table 3, associated with these themes are key terms and concepts of systems and service security concern, perception of security, administrative arrangement for examination, security tools disclosed, literacy and disclosure of security system, usefulness, readiness, use for examination, effort and performance, flexibility, system intelligence, and strategy and policy inputs.

4.1.1 Technical system support for security

Security as a smart classroom quality remains a key concern for educational technology, particularly in the context of the COVID-19 pandemic, with various platforms facing security concerns, with a Kuwaiti Assistant Professor noting that:

> "In general, there are security loopholes." (Int_11)

The overall perception of security is, however, dichotomous, because participants view security *administratively* to support evaluations of smart classrooms and *technologically* when considering smart classroom tools to prevent system interference from unauthorized system users:

> "The first one is the presence of the firewall which prevent reaching to the internal network except for those who are authorized to log in…it is coded (data encryption algorithms)…from the administrator side we have a security measures in the university… they provide training courses." (Int_23)

This integration of administrative service-oriented and technical system-oriented arrangement provides a congruent approach for security issues. Some of the participants further elaborate on aspects of administrative arrangements as follows:

> "When the student log in … take picture of them for security reason…when you do assignment there is timing." (Int_17)
> "Control of log in, participation time, control cheating, availability of the materials." (Int_26)

In these administrative arrangements for security, faculty tend to focus on aspects such as creating question bank to assigns random questions (Int_2), placing system restrictions (Int_21), allocating timing and place for examination (Int_26), and using passwords (Int_25).

Participants also disclosed some technical security tools such as encryptions (Int_4), QR codes (Int_12), firewalls (Int_23), and secured emails (Int_6). These tools exist in for supporting online classrooms with increasing use of cloud technology and virtual machines as noted below:

Table 3 Overview of quality attributes for technology platforms

Themes	Description of themes	Sub-themes	Quote
Technical system support for security	Security support in classroom concerns as perceived with various administrative measures, and technology tools that require minimal technology literacy and disclosure in universities.	Security concern	"Security is the most important issue for the university system" (Int_9)
		Perception of security	"Security in terms of the assessment refers to two issues. The first one is that how we make sure that the learners themselves who are taking the exam. The second thing is that we are using a very advanced security system with technological tools that support our major servers in this regard." (Int_16)
		Administrative arrangement for examination	"They already do their assignments in the classroom not at home and they submit it in Google drive at the same time." (Int_18) "University we have single sign-out facility means that students are able to text, and they can go for libraries and ICT labs." (Int_25)
		Security tools disclosed	"I faced the virus problem I asked them to use the 'clouds' and QR codes." (Int_12)
		Literacy and disclosure of security system	"We don't face something like hackers a lot and there is technical support for protection." (Int_28)

Table 3 (continued)

Themes	Description of themes	Sub-themes	Quote
Flexible analytics modules for intelligence	The use of flexible analytics modules is regarded useful as it helps enhancing readership, attendance, access to content, intelligence and flexibility of the system, facilitating examination, evaluating efforts & performance of the students, and providing inputs for strategy and policymaking.	Usefulness	"Because it is helpful for the students…and teachers." (Int_5) "That makes life is easier for us and for the student." (Int_29)
		Readiness	"These data, I use it at the end of the course to know who attend and who deserves prohibition or warning without any effort because the system does it automatically." (Int_12)
		Use of content	"What kind of material they used, what do they prefer of this material, what was wrong with some sort of this course items." (Int_16)
		Use for examination	"Yes, because before you put the questions you have to measure, this question has 20% and this question has 40%." (Int_13)
		Effort and performance	"Analytics plays some role for example analyzing my grades, my marks in different components... what's the class average, what's the division, how many students are in one grade." (Int_21) "We can know how many times our learner log in to the system and used the material." (Int_16)
		Flexibility	"These options [system analytics] are very important because make the system itself flexible." (Int_1)
		System intelligence	"We call [it] "mastering technology" which in the lecturer assign a topic here for the students and then the system will start to ask the students questions about the topic. If his answer is wrong the system is using artificial intelligent so it will give him a hint." (Int_17)
		Strategy and policy inputs	"a system in the university which is called business intelligence and it offers the data from their internal and external resources for the policy makers…this data gives the policy makers indicators about the achievements and the performance to compare that in the intended strategic plan and the goals according to his level in the organizational structure. That enables him to form a vision about the track of the performance if it is right or wrong." (Int_23)

Table 3 (continued)

Themes	Description of themes	Sub-themes	Quote
Integrated mobile application for accessibility	Importance of integrated mobile applications is regarded as having higher user-ship, easiness & accessibility, due to the availability of free applications with higher content, mobility and intelligent learning. The applications, however, need to incorporate compatibility and integration like other applications as well as application selection and disparity in access to technology and its knowledge.	The importance of mobile applications	"Even some quizzes and exams, I use it the whole time on the mobile." (Int_18)
		Higher user-ship, ease and accessibility	"The mobile phones offers easy applications for the students and for the teachers and they are available every time and everywhere." (Int_23)
		Compatibility and integration	"Mobile applications support e-learning strongly… but it must be compatible to the mobile." (Int_9)
		Application selection	"The problem is to choose the suitable application." (Int_7)
		Disparity in knowledge and device	"It's very important and easy to carry for the students but it depends on the type of the device." (Int_30) "We have some mobile applications … which make the students connected with their teaching staff. But I don't know what [is] inside." (Int_27)

"For the online classrooms we use Microsoft teams some security technologies like pair to pair encryptions." (Int_4)
"The cloud they will give you virtual machines and [you]will install the OS (operating system)… the firewall you have to upgrade it every year." (Int_31)

However, participants were either unaware of the security system or felt hesitant to share the security related details. Perhaps participants' felt sharing or disclosing information could jeopardize the security of their systems. Thus, participants either denied responding to related questions or expressed limited knowledge on the issue as shown below:

"I do not have technical experience about security." (Int_1)
"I think the security based on the IT department… I don't know the details." (Int_27)

4.1.2 Flexible analytics modules for intelligence

For the next theme, *intelligence as a smart classroom quality*, concerns the analytics that originate for data on system output and usage by teachers and students. Participants commented on the usefulness of system analytics because it eases the work of both students and teachers, i.e.

"That (analytics) makes life is easier for us and for the student." (Int_29)

Users of system analytics found the technology helps in finding trends in the attendance, the readiness of students in terms of time spent on reading materials or watching the educational videos provided, to enable teachers make more informed decisions about individual students i.e.:

"Through the smart classrooms I know who read and watched the post." (Int_2)

Along with analysis and readiness, the system analytics enables teachers to evaluate the suitability of the content through analyzing popular content, assessing issues with contents and identifying course items for any future versions of courses, as captured by an Emirati Dean for a School of e-Education:

"What kind of material they used, what do they prefer of this material, what was wrong with some sort of this course items." (Int_16)

Another important use of system analytics is for designing examination. The range of interest in using analytics include for analyzing and making corrections to examination questions (Int_12), evaluating the difficulty levels of questions (Int_13), and generating graphical representations of examination patterns to ascertain fairness in questioning and grades (Int_12). According to a Kuwaiti Assistant Professor in an Instructional Technology Department, the focus should be on right percentages for questions, i.e.

"I used "zip grade" to correct these exams and to analyze them to know which are the difficult questions and the easy ones…I analyze it and make a graph to show for the student to know that I was fair with all of them." (Int_12)

The data indicates that well-designed examinations through system analytics lead teachers to evaluate student efforts and consequential performance. For instance, participants suggested the following:

"It is like tracking their performance and then it is not only about their performance, tacking their efforts. For example, if I have given the task to my students that certain number of trials, I should be able to know that who did what at what time, how many attempts they did, it the first and the second attempts what was his performance." (Int_15)
"System generates analytics, so it tells you exactly how long the student spends in reading the text, how many times he watched the video and repeated it and so on." (Int_17)

Another aspect of system analytics is access to multidimensional information that makes the teaching and learning experience more flexible and adaptable, as noted by a Qatari management academic:

"These options [system analytics] are very important because make the system itself flexible." (Int_1)

With continued system use, advances using technologies, like artificial intelligence (AI), improves system ability to learn and predict user behavior and requirements, as noted by an Omani Head of e-learning:

"we call[it] "mastering technology" which is when the lecturer assigns a topic here for the students and then the system will start to ask the students questions about the topic. If his answer is wrong the system is using artificial intelligent so it will give him a hint." (Int_17)

Overall, in-depth information contributes to quality because large data-sets enable universities formulate strategic policies beyond the classroom, as argued by a Saudi Associate Professor:

"a system in the university which is called business intelligence and it offers the data from their internal and external resources for the policy makers…this data gives the policy makers indicators about the achievements and the performance to compare that in the intended strategic plan and the goals according to his level in the organizational structure. That enables him to form a vision about the track of the performance if it is right or wrong." (Int_23)

Despite these useful aspects of system analytics, there remains room for improvements particularly in increased awareness and capacity building for faculty, as reflected in minimal use of system analytics among participants.

4.1.3 Integrated mobile application for accessibility

The next theme for *accessibility as a smart classroom quality* reflects evolving environments for smart classroom towards compatibility and support for mobile applications because these applications offer a range of benefits for teachers and students. According to two Emirati and Kuwaiti academicians:

> "Most of the application[s] are available in the mobile…currently [student] are more interested using smart phones for smart classroom." (Int_15)
> "Even some quizzes and exams, I use it the whole time on the mobile." (Int_18)

Benefits of mobile applications include higher usership, ease of use, and accessibility. Significantly, mobile phone use remains popular and integrated mobile applications create classroom opportunities as noted by an Omani LMS Administrator and Web Master:

> "It's a very good tool to use because now everyone has his smart phone and he can access the internet." (Int_4)

Higher usage extends beyond number of users to durations spent on mobile phones. Overall, high usage stems from mobile features supporting user interactions e.g. user-friendly interfaces and ease of access. Harnessing these features for supporting smart learning is the focus of remarks such as:

> "When they use the mobile, they interact a lot because it became an essential part of their lives. Anytime I can ask them to download any program on their phones, it is usually simple and easy." (Int_14)
> [Students] can download it and catch up with your lectures anytime and anywhere you nail it." (Int_22)

Another factor within this theme is the availability of mobile apps that generally tend to be free, as noted by a Kuwaiti academician:

> "Most of the programs on it [mobile phones] are free like "keynote ". They need not to buy. Most of the programs I use are suitable for the Android and IOS in iPhones and iPads." (Int_2)

Mobility is another aspect of this theme that complements flexibility, availability and accessibility for users, i.e. teachers, students and administrators. With increasing support for the mobility of learning content, participants remarked on opportunities for customizing content according to user needs and experiences, particularly through intelligent learning systems, i.e.:

> "The mobility of the content is everywhere like for example open education resource…mobile learning in the future will support the adoption and intelligent learning system you can reach your content and your people everywhere anytime." (Int_16)
> most of the course[s] are on the mobile, so they interact more and more. The mobile is always with the student everywhere and every time." (Int_2)

However, accessibility depends on support for compatibility and integration with older applications and devices, especially when segments of users own these types of applications and devices. The following excerpt from a Saudi Assistant Professor within a College of Business highlights this concern:

> "The new software it is compatible with the smart phones but the old one it's not." (Int_27)

Another Qatari Lecturer of Educational Technology noted concerns regarding the selection of relevant mobile applications, i.e.:

> "The problem is to choose the suitable application." (Int_7)

Increasing numbers of applications creates ambiguity and disparity among the users with increased prospects for incompatibility. However, more challenging disparities emerge in relation to generational gaps between teachers and students. Here, the concern is the link between age groups and familiarity with technologies. As suggested by the following excerpts, students tend to have greater command and knowledge of applications and devices in comparison to instructors who, during most of the interviews, indicated that applications tended to be difficult:

> "Most of the students have modern mobiles more than the teaching staff themselves" (Int_30)
> "Students can respond effectively to use the difficult mobile applications" (Int_1)

4.2 Quality attributes of social interaction

Next, the study finds quality attributes of social interaction. Table 4 shows that the attributes include (i) self-determined content and choices for diversity, (ii) program-oriented discussions and dissemination for interconnectivity, (iii) Game-based materials and methods for simplicity, and (iv) self-confident participation and perceptions for sensitivity. The table outlines these themes and the next subsections present these findings.

4.2.1 Self-determined content and choices for diversity

With focus on social interaction, the emphasis lies on personalized learning that enables *diversity as a smart classroom quality* with relative pros and cons. Diversity of content with choices for users emerges from various attributes of the system such as the options, topics, and level of contents (Int_1), and the ability and learning behavior of the users (Int_2) (Int_4). This diversity enables the system to adapt to various contexts of individual users, as highlighted below:

> "This is a great advantage that each student has an education suits his mental abilities, and his personal interests, and the system of education he prefers." (Int_2)
> "Technology cares about the individual differences between students." (Int_24)

Table 4 Overview of quality attributes of social interaction

Themes	Description of themes	Sub-themes	Quotes
Self-determined content and choices for diversity	User determined content is enabled through diversity in the system parameters with relative pros and cons.	Diversity	"Students have certain interests and educational methods so the system itself provides them with the topics they search for a lot and suitable for his level."(Int_1) "have different learning styles, for example some people they can listen to something to get the information, others they like to watch something virtual to get the information, some people it's easy for them to read texts, we have to make our material to suit all of these learning styles." (Int_4)
		Pros and cons of personalization	"Students become more motivated when using personalized learning." (Int_1) "I prefer through the personalized learning for the students. They don't only take the information from their instructor, but they do search and think more." (Int_6) "Students aren't ready to choose what they should study especially the teenagers as they don't have a clear vision about their future so there should be a supervisor to direct them well. (Int_11)

Table 4 (continued)

Themes	Description of themes	Sub-themes	Quotes
Program-oriented discussions and dissemination for interconnectivity	Students discussions happens through modes or touchpoints for interaction that leads to different feelings and response to the interaction	Modes or touchpoints of interaction	"I always use the discussion, games, and programs with my students during the lecture…my graduate students they always say that we could not forget your lecture because of the interactivity." (Int_2 "We have interactive smart board in the classrooms. They can go and share the knowledge with other students." (Int_4
		Feeling and response in interaction	"There is a great interaction." (Int_2) "but if you don't know how to use smart technology it will be hard for you to make the same type interaction affected in face to face classes, so it depends on the knowledge and the background of how to use technology." (Int_15)

Table 4 (continued)

Themes	Description of themes	Sub-themes	Quotes
Game-based materials and methods for simplicity	Students' involvement in the content and pedagogy enhanced with game-based content and simple methodology	Diversity of content & pedagogy	"When you put an interactive program, students will deal and interact with it and with the information, ask, object, suggest, have notes, ask for more information." (Int_19) "You need to make your lecture as much entertaining as you can." (Int_22) "They even sometimes they are learning through online games, quizzes, and they are using some online tools." (Int_25)
		Learners' attributes and habits	"Yes, because in our class, the doctors always talk and discuss with the students. This is the traditional teaching." (Int_13) "Yes, if you ask your students to see some videos and come prepared the majority of them like that and they are active learners." (Int_21) "I can say that electronic learning depends on self-learning." (Int_28)

Table 4 (continued)

Themes	Description of themes	Sub-themes	Quotes
Self-confident participation and perceptions for sensitivity	Student attitudes exist as perceived by teachers with apparent stimuli and sensitivity	The perceived attitude	"At the beginning especially students who haven't done this before they need some training. And now all students have smart phones and they use social network. That is not far from what they are using." (Int_3) "As for my experience, implementing so many courses for so many years the attitude is positive and I'm expecting more positive attitude in the coming time." (Int_15)
		The stimuli of attitude	"We are in a discreet society, so it is not allowed to turn on the cameras at home especially for females." (Int_7)

In relation to the pros and cons of diversity, on the one hand, social interactions and interests thrive, as noted by a Qatari academician:

"Their engagement and motivation will be increased." (Int_1)

However, on the other hand, increased interacts magnify workload for instructors as suggested by a Kuwaiti Professor for Curricula and Teaching Method & E-learning:

"It is a load on the instructors. Another challenge is the assessment problem. Because the system depends on exams, there is no space for assessment as we bounded by the final assessment." (Int_9)

4.2.2 Program-oriented discussions and dissemination for interconnectivity

Interviewees note that students' interaction, focused on degree programs, happens through modes or touchpoints of *interconnectivity as a smart classroom quality* that lead to a variety of feelings and responses to interaction. These touchpoints involve modes or interfaces that support learning e.g. discussions, games, programs, interactivity, interactive smart boards, holograms, AR techniques, participation, mobile and social media, WhatsApp and discussion boards. The following quote from a Kuwaiti academician suggests increased potential for learning derived from these different modes:

"There is unbelievable increase in the interactivity. I used the 'AR' technique in my book 'educational technology encyclopedia'". (Int_6)

In addition, interconnectivity using technology also stimulates various emotions among users. Such emotions are usually expressed through words such as great, helpful, good and strong, better and interesting, freedom, know how, happy, and attractive, e.g.

"Using technology is very easy and better and interesting." (Int_13)
"The interaction is great." (Int_30)

Such emotion-led rhetoric creates a context for social interactions but also different challenges of assessments for the technology, i.e.

"So the interaction is very good and they are always co-operative. Technology is always changing and developing so it is too hard to do an assessment for the technology." (Int_24)

4.2.3 Games-based materials and methods for simplicity

Within the study, an important emerging quality theme is *simplicity as a smart classroom quality* for content to enhance student involvement and pedagogy to ease integration of technology by instructors. Using interactive whiteboards, photos, maps, graphs, flowcharts (Int_1), the focus on simplification involves

adapting these tools for enhanced participation, games-based, and sometimes even easy and fun social interactions (Int_4). This simplicity-focused use of tools enables learners to find the in-class interaction more entertaining and the quizzes perceived as games. The following excerpts reflect these considerations:

> "By using the smart classroom technology and interactive whiteboard the information can be demonstrated with the help of photos, maps, graphs and flowcharts. Of course, these options encourage the students to be more engaged. This makes learning more attractive and interesting and easy to understand because it encourages the students to have the ability to learn and memorize when the students have more options." (Int_1)
> "Sometimes you find students feel shy to participate or interact with you in the classroom. But when it comes to converting it into a game or something easy or funny for them, they can accept they interact with you within the classroom. You have to find the way to convert your material to be funny, and people these days and talking about gamification." (Int_4)

Impacting simplification as a quality attribute is the learners' and instructors' attributes and habits. These attributes include discursive skills (Int_13), gender (Int_14), and preparation habits (Int_21). An Instructional Technology specialist discusses these other attributes and habits as follows:

> "I depend on my skills to create harmony groups. It's easy for me to communicate with the male students than the female ones because I know their way of thinking; I was going out with them to the locations during making videos. The gender is a very important factor in the social context because when I discussed my problem with my female colleague, she says that she didn't face the same problem with the female students as I faced. So that may help you in your research context." (Int_14)

4.2.4 Self-confident participation and perceptions for sensitivity

Another theme from the interview concerns user attitude and awareness that creates a dilemma for using technology in learning. The interview suggests *sensitivity as a smart classroom quality* during social interaction as shaped by prolong trainings (Int_3), and making users feel at ease during interactions (Int_4) and developing positive attitudes (Int_15). For interviewees, attitudes shaped by participation and perception remain an issue of personalization for services, as argued below:

> "Before the recent situation "Corona virus", the participation or the behavior of the students with the online material it was not like now. But now I can tell you that all of our students are enjoying, and they are active, and they find it easy for them to participate online classes beside they don't feel shy as in the classroom now it's good for them to be behind the screen." (Int_4)
> "The perception itself goes to the issue of personalization. If our learners are satisfied with the services that you are offering to them in terms of the academic services, advising and counseling or the career advising or counseling,

so it depends on the dimensions of the service you are adopting or applying in your institution." (Int_16)

In addition to the role of participation and perception in shaping sensitivity during interactions, the analysis notes the role of social media, and budgets, as follows:

"I think our perceptions are based on student's perceptions. From my side I see that students are very confident in using technology." (Int_1)
"They are more attached to the social media more than available traditional platforms in the university." (Int_21)
"The e-learning is already applied and equipped, but still the administrators are better than the students as they are few and in one building. The students are too many, so it requires a lot of money and a great economic budget for the university to equip 5 buildings for the students." (Int_30)

4.3 Smart classroom contexts influencing the quality of education

Another set of themes from the study involves smart classroom contexts that influence the quality of teaching and learning. Here, the analysis of the interview data identifies themes concerning strategy-oriented planning and priorities for adaptability and cost-driven transformation and technologies for affordability, as shown by Table 5.

4.3.1 Strategy-oriented planning and priorities for adaptability

Viewed in the wider context of educational institutions, the future of smart classrooms depends on and demands strategies for *adaptability as a smart classroom quality* based on planning and prioritizing resources. For interviewees, clearly defined visions and missions are essential for successful smart classroom innovation in the future (Int_6) (Int_17) (Int_23). Visions and missions with forecasts for the integration of disruptive technologies and pedagogies (e.g. holograms and multi class teachings) would require changes in rules and principles of education, i.e.

"If you don't change your rules, if you don't change your principles, it will stay as it is now, but I hope in the future it change." (Int_18)
"We have something which is called the strategic planning. it concerns with the planning for the future." (Int_23)

However, strategy planning has the limitation that it cannot predict the range of futuristic tools that could be available for smart classrooms, since

"We can't talk about a definite tool because technology is changing and developing. So, the content is more important than the tool to apply" (Int_11).

Nonetheless, there is a need for adaptability using current tools and exploring options available for advancing smart classrooms such as

Table 5 Overview smart classroom contexts influencing the quality of education

Themes	Description of themes	Sub-Themes	Quotes
Strategy-oriented planning and priorities for adaptability	The future quality of smart classrooms depends on the existence of strategy-oriented efforts.	Strategic Orientation for Smart Class Innovation	"As for the policy makers, they don't have economic problems, but they need to arrange their priorities to fit with e-learning." (Int_14) "As far as I know this is the best program. I'm not aware if there is intention to change anything in the future." (Int_22) "We have a successful system of blackboard and Moodle, so I don't think that they have the intention to change or to replace it." (Int_30)
		Non-specified tools emergence	"After this crisis, I'm sure that they will improve these programs." (Int_10) "So, the university enroll has taken a lot of measures in improving teaching and learning." (Int_15) "There are new technologies, everywhere we provided with data shows, smart boards, and computers." (Int_20)

Table 5 (continued)

Themes	Description of themes	Sub-Themes	Quotes
Cost-driven transformation and technologies for affordability	The key barriers to quality of smart classroom are pointed out as the attributes of social make-up and the cost-driven transformation with associated administrative readiness.	Attributes of Social make-up and Tech Adoption	"The challenge is how to make the teaching staff ready to apply distance learning…We must convert the culture, the courses, and the contents to fit with e-learning." (Int_14) "Barriers mainly are the acceptance by the students and the faculties…Sometimes the major barrier are financial like in India, it is a costly kind of technology, but in GCC particularly in Qatar they have a lot of money which enables them to offer equipment." (Int_21) "We need specialists to convince people; even the minister himself isn't mastering the issue because it is not his field. Their role is to make the parents feel safe and to promise them to find alternative ways and solutions"." (Int_24)
		Economic and Stakeholders Readiness	"Resistance of change, it is number one. We need some change managements…, instructors in Arab countries it would be more difficult to implement the classroom… Each lecture hall is a smart classroom. It is shame; I know most of the instructors don't use them. It's a shame…It is not another of buying equipment. You need a training program you need to enforce them by the top management, and you need to change management because resistance of change will happen….I guess that the policy is the main issue." (Int_3) "I think the biggest barriers are economic and administrative problems. The administrative routine is so bad and always delays to response for our requests." (Int_8) The cost! Technology is not cheap…Attitude. Some of them. For example, you know I'm sorry about that sometime professors, and PhD holders they don't accept to get a train by master or Bs holders." (Int_31)

"Blackboard, Microsoft teams, web-x. Now we have the ability to deal with all options, in case there is a problem with one tool we can go to the other tool." (Int_1)
"There are many promises but in fact the applying of them is zero…We can't talk about a definite tool because technology is changing and developing. So, the content is more important than the tool to apply." (Int_11)

4.3.2 Cost-driven transformation and technologies for affordability

Challengingly, the integration of new technologies for transforming conventional classrooms towards smart classrooms (or enhancing technologies in smart classrooms) is also a cost-driven concern. Thus, *affordability as a smart classroom quality* remains a focus for educational institutions with implications on the configuration of resources and administrative readiness. Transformations require social actors and a culture that reinforces learning in smart classrooms. In this context, the argument is that technology adoption requires "both culture and policy" (Int_29) with the interviewees giving accounts and suggestions such as

"I faced a big challenge to convince students to use technology. They are impressed with technology but while applying they cannot. I tried to discover the reason and I found that the students have a problem in their culture itself." (Int_6)
"you need to teach your staff about how not to use the program…You need to see whether the instructors can make them engaged. So, I think. This is the main barrier." (Int_22)
"Regulations, cost and internal academic culture." (Int_26)

Inevitably, resistance to transform conventional classrooms into smart classroom is an economic and readiness issue. Such concerns arise due to infrastructural needs (Int_7)(Int_12). Such infrastructural needs demand resources along with active policy, academic, and administrative support to achieve success, i.e.

"I think the infrastructure, and we are as professors we find it difficult to ask the females to turn on their cameras at home. As for the technical issues I find it easy in the university environment." (Int_7)
"The society culture to accept technology. There is economic challenge as well. There must be infrastructure divided between the government and the parents. They must provide equipment, computers, smart devices….There must be training courses for students, instructors, and parents. There must be an educational material." (Int_12)

5 Discussion

Technological advances have the potential to revolutionize teaching and learning. Importantly, the emergence of smart classroom remains at the center of ongoing transformations in the education sector. However, such transformations require joint

evaluation of the technological and social aspects of smart classrooms in pursuit of enhanced quality teaching and learning. As Kwet and Prinsloo (2020) noted, participants in smart classroom environment should collectively determine what 'smart' classrooms should be and how the phenomenon will develop. Motivated by this challenge, this study relied on findings from higher education teachers to utilize their exposure to smart classrooms. Notably, smart classrooms are inherently better than traditional classrooms if their superior features are utilized to ensure technological competencies, pedagogical competencies, social competences, and didactic competencies (Oubibi et al., 2022). However, having an optimal smart classroom is beyond developing a system design guaranteeing efficient and functional mode as Zheng et al. (2019) argued.

In designing the model that best illustrate effective smart classroom use, the interlinked nature of technological and social factors as well as the quality contexts should be evident in smart classroom management, administration, and policy. This view is different from Zheng et al. (2019) who focused on developing the smart learning system and from Dos Santos (2019) who focused on social factors only.

Technology forms the foundation upon which smart classroom use is based. Emphasis on technology should be on user security, educational intelligence, and technology accessibility. Among the measures to enhance the technology is to provide technical security support, develop a flexible analytics module, and ensure mobile application integration. However, pedagogical issues associated with reliance on technology to improve interactivity have attracted researchers' attention. Ensuring students are focused and responsive in classroom contexts is among the most challenging tasks because it depends on various factors. The factors range from lecture delivery style, classroom events, experiences, and discussions (Kaur et al., 2022; Yu et al., 2022). Thus, smart classroom designs necessitate attention on the social factors that impact system diversity, interconnectivity, simplicity, and sensitivity in tandem with technological factors. In this case, smart classroom use should be driven by self-determined choices and content, program-oriented discussions and dissemination, game-based resources and methods, and self-confident participation and perceptions. While interlinked, both technological and social factors operate under quality contexts shaped by system adaptability and platform affordability. Strategy-oriented planning and priorities together with cost-driven transformation and technologies play vital roles in determining the moderating role that quality contexts have on smart classroom quality. The findings of this study show that effective smart classroom use entails consideration of the revised conceptual model illustrated by Fig. 2. Figure 2 was derived following reflections on the themes from the interviews, with considerations for Fig. 1. The process involved analyzing the themes and splitting each theme into two concepts: (i) the first part of the theme that relates to management, policy, or administrative challenges, and (ii) the second part that considers attributes for users, systems, and platforms. In effect, the model regroups and frames smart classroom use as a function of management and quality factors.

The findings of this study, as presented in the revised conceptual model of Fig. 2, suggest considerations for effective smart classroom use. The figure reaffirms the suggested influence of socio-technological factors required for achieving smart classroom quality, as proposed by Fig. 1. However, the revised model additionally considers

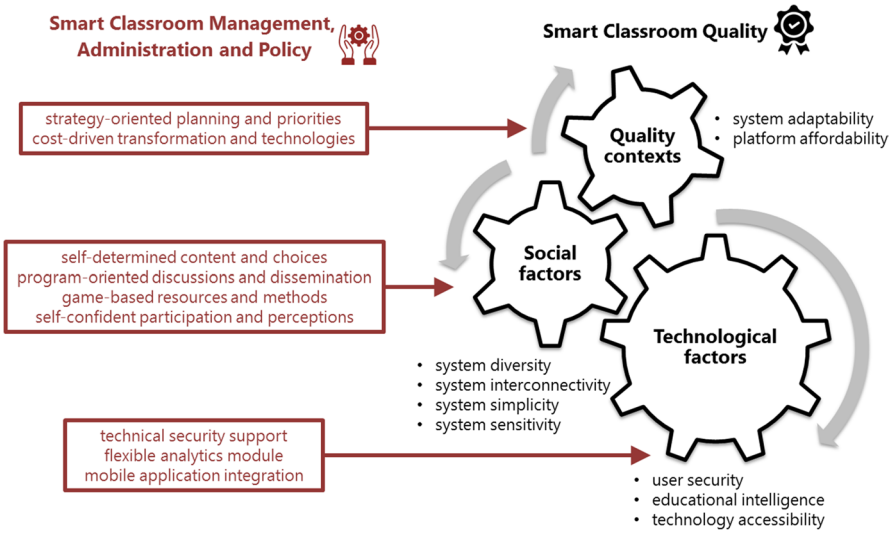

Fig. 2 Revised Conceptual Framework for Smart Classroom Use

quality contexts according to the adaptability and affordability of systems. The next subsections discuss the theoretical and practical implications of this research.

5.1 Theoretical implications and significance

From a theoretical perspective, this study implies that smart classroom quality poses a research challenge central to the quality of education in the 21st century and that quality attributes from a socio-technological perspective are essential to smart classroom design. This study makes theoretical contributions in three ways. First, while various studies seek to examine the determinants of IT innovation adoption, limited emphasis has been on the design for smart classrooms (Dong et al., 2019; Wu, 2016). Since smart classrooms are fundamentally innovations for education, most studies have focused on investigating adoption of smart classrooms as innovation with the main interest being on the diffusion among educational institutions. This study adopts a different approach by focusing on aspects that influence smart classroom design by considering technology and social factors. Considering smart classrooms as technology-rich classrooms, the findings of this study offer quality attributes to study and evaluate spatial designs and technology equipment use in strategies, models and inventory for modern classrooms and learning systems.

Second, this study complements existing research suggesting that performance of smart classrooms depends on the integration of new management systems and services to facilitate implementation (Aguilar et al., 2018; Uskov et al., 2019). The interview findings reveal that smart classroom involves implementing modern ICTs in a particular social context to increase collaboration and innovation, ensure better communication between teachers and learners, and enhance the overall efficiency

of learning. In practice, management services and systems assume a central role in facilitating interactions with classroom content and easing learning content creation and sharing. This research argues that the effectiveness of smart classrooms depends on both monitoring activities of learners and harnessing the capacity to track progress in learning using smart teaching and learning applications. In this context, the management aspect of interest in smart classrooms requires teachers to be able to use evaluation and monitoring functionalities to assess individuals' performance, create interactive lesson plans, and run surveys to inform appropriate changes.

Third, the findings of this study support the need for institutions and researchers to shed light on future smart classroom innovation factors to accommodate inevitable advances in technology, as suggested by previous studies (Li-Shing et al. 2019; Cebrián et al., 2020). The objective should be to improve technical security support, have a more flexible analytics module, and guarantee superior mobile application integration to ensure streamlined running of smart classrooms. Such need arises because the phenomenon of smart classrooms is still in the early stages of development. Thus, research pursuits on the quality of smart classrooms should factor systems and services together with evolving technology and design. Attention to emerging technologies with prospects for smart classroom innovation should inform the strategy that educational stakeholders adopt in their pursuit of quality.

5.2 Practical implications and significance

Effective teacher preparation assumes a central role in determining learning outcomes (Paraschivescu & Savga, 2016). Consequently, the success of smart classrooms remains pegged to the extent to which teachers can comfortably use smart teaching and learning systems. The implication is that adminstrators should pay close attention to the ease with which educators use smart technologies to boost adoption, diffusion, and utilization. Furthermore, adminstrators should realize the effectiveness of smart classroom learning significantly relies on the extent they ensure learners make self-determined choices and content, engage in program-oriented discussions and dissemination, utilize game-based resources and methods, and exude self-confident participation and perceptions. The integration of smart classrooms training programs for instructors can be vital to deal with potential resistance to change among users captured in this study. Importantly, attention to teachers' training remains vital to ensure the education institutions sustain competitiveness in providing superior educational services.

The findings of this study stress the need for quality attributes as factors that significantly influence smart classrooms adoption. The focus is to have an affordable platform and adapt its system to ensure optimal effectiveness in learning. Awareness of quality attributes should serve as the basis for regional considerations concerning infrastructural and technical support for education. In this study, insights emerge from the GCC region with practical implications to harness the findings for strategy-oriented planning and cost-driven transformations with technical support for boosting the quality of education. Overall, competence in technical aspects of smart

classroom systems remains a priority for the region to solve critical problems facing educational institutions in GCC countries effectively (Al-Hunaiyyan et al., 2017).

This study addresses the research objective on what academics consider important for ensuring quality of the design spaces, configurations, and environments of smart classrooms. Policies on smart classroom use should concurrently include technological factors, social factors, and quality contexts for the concept to effectively develop higher-order thinking and metacognition among learners and to utilize interactions effectively. Consistent with Dong et al. (2019), the design spaces, configurations, and environments of smart classrooms should reflect these considerations. The awareness of these considerations further helps meet objectives of sensitizing policymakers. The study provides a comprehensive perspective on measures that policymakers can advance to realize seamless adoption of smart classroom use. Technology adoption especially in higher education is inevitable and the study offers valuable insights that policymakers and administrators could consider for ensuring quality education in smart classroom.

Finally, this study advocates for socio-technological quality as an avenue for ensuring fit or alignment of tasks with technology for educational stakeholders i.e., instructors, learners, administrators, etc. This fit has implications for smart classroom *developers* to produce systems that support higher-order thinking and TQM4E. The study implies that administrators, governments, and developers should factor the quality of technology platforms and social interactions in strategies, policies and designs for educational programs and curriculum that involve smart classrooms and for boosting the adoption, diffusion, and utilization of smart classrooms. This research urges developers to analyze user behaviors beforehand and to customize technologies for smart classroom to ensure fit with unique tasks conducted in educational contexts. Therefore, smart classrooms should exhibit social compatibility with respective institutions and their systems. Overall, focus on smart classroom quality means that educational institutions need to make necessary changes to improve the compatibility of smart classrooms with respect to IT systems and user behaviors. The complexity of smart classrooms due to a wide range of integrated systems and services could impede decisions to use smart classroom particularly with organizational resistance to change for some educational institutions.

5.3 Research limitations

This research has several limitations that result from constraints during data collection, focus on the GCC region, and the qualitative nature of the study. Data collection was through virtual interviews as part of the "social distancing" measures meant to curb the spread of COVID-19. Consistent with Krouwel et al. (2019), the viewing perspective in virtual interviews limits access to body language. Reliance on camera implies that both the interviewer and interviewees contend with peculiar eye contacts. Moreover, virtual interviewing increases the likelihood of social interruptions because the interviewer and interviewee are in separate locations. The study is also limited to a socio-technological context for quality concerning smart classrooms.

Economic and ecological concerns are examples of some other potentially influencing factors. Focusing on barriers or inhibitors to smart classroom quality could shed light on the implications of failure due to inadequate staff training, lack of resources, and burnout due to heavy workloads. In addition, the research gathers insights from academicians in GCC countries with potential issues in interpreting and generalizing the findings elsewhere. Furthermore, the non-random sample used does not reflect general education stakeholders. Failure to randomize the sample potentially introduces the risk of bias with implications on the generalization potentials to a broader population because the non-random sampling introduces biases and potentially skews the findings. Another critical limitation of the study is its adoption of a qualitative methodology. The main concern in using qualitative methodology again relates to the validity of generalizing results to the larger population. The need for quantitative inquiry, e.g., through a survey, remains. Despite these, the exploratory nature of this study and richness of qualitative data offers potential to advance knowledge to improve the quality of smart classrooms.

6 Conclusion

This study investigated the current status of smart classrooms and identified technological and social factors impacting the quality of education in smart classrooms. Using interviews with academicians in higher education within the GCC region, the study found three quality attributes (user security, educational intelligence and technology accessibility) associated with technological factors and four quality attributes for social factors (system diversity, interconnectivity, simplicity and sensitivity) (addressing RQ1). The study also identified two quality attributes (system adaptability and platform affordability) for smart classroom contexts that influence the quality of education. The study suggests that the challenge is for policy-making to influence quality attributes through strategy-oriented planning and priorities and cost-driven transformation and technologies (addressing RQ2). The implication from this is that the management strategy employed in adopting smart classroom determines the achievement of technology alignment and adoption.

The findings from this study are crucial for successful implementation of smart classrooms against the socio-technological challenges identified. Successful adoption of smart classrooms depends on addressing both social and technological dimensions of quality. Due to the limited focus on socio-technological factors in the GCC region and the qualitative nature of the study, future research should quantitatively test socio-technological dimensions of quality for smart classrooms in wider geographical contexts. New challenges associated with quality attributes could also be the subject of future studies. Further studies could examine learner (and other stakeholders such as administrators) contexts and additional dimensions for smart classroom quality e.g., economic and ecological perspectives.

The study suggests that multiple dimensions of ensuring quality in smart classrooms are subject of growing significance as the popularity of smart classroom rises. However, this study relies on qualitative insights 31 participants. Accordingly,

the sample could be enlarged in future studies and more sophisticated data analysis methods adopted. Furthermore, future studies can conduct comparative exploration of the quality of learning and interaction patterns of variables should particularly receive attention in future studies. Moreover, further studies could investigate ways of improving teachers' competency amid insights gained from this study.

Appendix

Sample case study questions

Background questions

1) What is your name, position in the university?
2) How long you have work in the university? And within your current position?

Technological factors

1) What security measures are important for using technology in classrooms? And for smart classrooms?
2) How important are system analytics in teaching and learning? And for use in smart classroom?
3) How important is support for mobile applications in applying smart classroom for learning and teaching?

Social factors

1) What are the benefit and the challenges for personalized learning through smart classroom?
2) How is student interaction influenced by the presence or use of smart room technology?
3) Do you find that students are more engaged if you use smart room technologies (such as projecting images or videos, sound using speakers, etc.)?
4) What is your perception of students' attitudes towards the use of technology in the classroom?

Data availability All data generated or analysed during this study are included in this published article (and its supplementary information files).

Declarations

Conflicts of interests/ Competing interests The authors have no conflicts of interest to declare that are relevant to the content of this article.

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