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Emerging E-learning trends: A study of faculty perceptions and impact of collaborative techniques using fuzzy interface system

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ABSTRACT

This study explores the emerging trends in e-learning from the perspective of university faculty, who play a crucial role in shaping the future of education. The rapid shift to digital education during and after COVID-19 has presented challenges for university faculty to grapple with new e-learning technologies. A qualitative research design was used to develop deep insights into upcoming e-learning trends. Data were collected from a sample of 70 teachers (35 males and 35 females) through a random sampling from the university faculty in the capital territory of Pakistan. The data collected through semi-structured interviews was analyzed qualitatively for thematic analysis using a fuzzy inference system on MATLAB, resulting in a system accuracy of 92% and a miss rate of 8%. The study identified important e-learning trends such as artificial intelligence, video-based learning, social collaboration, mobile learning, gamification, and micro-learning, emphasizing their potential for engagement and outcomes. The implementation of these strategies can significantly impact the education system, particularly on learning systems. The findings underscore the importance of universities focusing on strategic planning and faculty development. Moreover, institutes that adopt ethical policies can transform the academic environment and establish innovative structures that benefit both teachers' work and foster students' engagement, ultimately leading to improved efficiency and effectiveness. The study's findings are crucial for shaping the future of e-learning and its potential impact on the education system.

1. Introduction

With the increasing technology integration in education, it has become easier to educate learners from various geographical regions where it is difficult to reach. The e-learning concept, keeping in view computer-assisted instruction, is being adopted globally, and the need for e-learning tools and methods has been rising subsequently (Hussian et al., 2024). This significant advancement of the Internet and technology has not only prompted the education sector to adopt internet-based learning resources from elementary to higher education but also empowered educators and administrators to be more flexible and responsive to the needs of their students. This sense of control and

effectiveness is a key benefit of e-learning (Afzaal et al., 2022; Imran et al., 2024). The potential of e-learning to significantly improve the efficiency and effectiveness of education is a reassuring sign of its benefits.

'E-learning' as a term refers to the integration of digital technology tools to facilitate online and blended learning systems, materials distribution, methods, and distance learning (Bailey et al., 2022; Shahzad et al., 2024; Hussain et al., 2024). In today's digital age, the importance of an e-learning environment is influenced by the benefits it offers. Higher education institutes should promote a collaborative learning environment to help students acquire information more effectively and improve their performance (Imran & Almusharraf, 2024a, 2024b;

Younas et al., 2022). Recent studies show that many higher education institutions have adopted e-learning tools and technologies such as Learning Management Systems (LMS), Massive Open Online Courses (MOOCs), and Virtual Reality (VR) as a cutting-edge approach to pedagogical instruction through online and blended learning (Hussian eta l., 2024; Imran et al., 2024; Charbonneau-Gowdy et al., 2023). In this context, embracing information technology in teaching and learning not only reduces classroom limitations but also amplifies student-to-student communication, consequently enhancing the effectiveness of learning. This sense of progress and achievement can be a powerful motivator for students.

The current study is significant in exploring how e-learning allows instructors and learners to benefit from emerging e-learning trends by participating virtually in the educational process. Moreover, this study highlights many advantages of e-learning systems in higher education, such as effortless team collaboration, low-cost study sources, mutual discussions, seamless interactions between instructors and learners, and easy access to content. This sense of community and connection is a key benefit of e-learning that can make educators and administrators feel more engaged and connected. However, despite e-learning benefits, the faculty faces a few potential challenges that may significantly impact the culture and ongoing needs for technical skill development. In particular, E-learning success depends on instructors' and learners' skills, approaches, knowledge, and perceptions in utilizing information and communication technology (ICT) systems. Evaluating academic progress is an essential component of the curriculum and vital to the educational process.

In the rapidly evolving field of education, Computer-Assisted Instruction (CAI) has significantly altered pedagogical methods, aligning with the focus of this study on emerging e-learning trends and faculty perceptions. This research investigates how CAI shapes faculty approaches to teaching and learning, which is crucial for understanding its impact on educational innovation. Zinn's (2000) introduction of CAI is considered one of the bases that have made it possible for the emerging field of e-learning systems to radically conceptualize the intersection between knowledge and pedagogical practices (Bonsu et al., 2020). In their study, Mirgorodskaya et al. (2023) discussed the postindustrial era; higher education systems are crucial in mitigating economic and cultural structures and adapting them sustainably to global risks. The transformation of higher education requires a coordinated model to identify change strategies for dynamic processes. It is critical to recognize that the global educational environment is an integrated entity, emphasizing intellectual activity, seamless communication, and the use of global information resources.

CAI was known for helping interactive discussion practices, drilling tasks, tutorials or practice tasks, and tutorial sequences, creating a transformative learning experience. E-learning technology speeds up this process by enabling critical thinking and research skills to be developed through a new learning environment that promotes independence among online courses (PSU Ref). However, there is an apparent lack of knowledge regarding how learner outcomes are enhanced by these new e-learning trends, as noted by (Aparicio et al., 2016). The significance of technological tools in instructional design for e-learning study is stressed by Hung and Chou (2015), as well as the various roles that teachers can play in online education. E-learning technology has disrupted education, starting from CAI, which ignited this development. In addition to changes in disciplinary cultures, the introduction of digital technology highlights the need for educators with many digital competencies (Turnbull et al., 2021). Although online learning is gaining popularity, there is still insufficient understanding of how upcoming trends influence student outcomes. Despite more comprehensive research on the efficiency of these tendencies, it remains true that the rapid advancement of technology makes education more flexible and accessible. The rise of e-learning has revolutionized education, determined by technological advancements and the need for flexible learning (Ouariach et al., 2024).

The significance of this research lies in its examination and identification of modern e-learning directions that can reshape educational systems for the better. Understanding and integrating these trends are fundamental for educators, policymakers, and institutions striving to offer practical and inclusive learning in an era characterized by rapid technological advancement and global connectivity. By doing so, we shall realize that they enable teachers to adapt their teaching methods accordingly to match the changing needs of learners in a world turning into digitalized/interconnected settings. In addition, the study presents practical suggestions on how educational institutions can take up these patterns in their practices. This paper helps decision-makers, educators, and researchers see the potential transformed through contemporary e-learning tendencies. Thus, adopting them can pave the way for more engaging learning experiences that promote inclusivity and better academic results, creating a dynamic classroom for both instructors' improvement towards enhanced engagement with students as well as higher levels of education attainment by the same students themselves. At the same time, learners benefit from such approaches, too.

This study explores contemporary trends in e-learning, highlighting how the integration of emerging technologies can enhance educational efficacy and inclusivity. This research aims to significantly elevate learning outcomes and adaptability by guiding educators and policymakers, thereby improving education standards in the digital era.

2. Research objectives

1. To explore the current and upcoming trends in educational systems.
2. To investigate how educational institutions can adopt and implement these trends effectively.
3. To determine the most effective strategies for integrating these trends into educational systems successfully.

3. Research questions

1. What are the future trends in the development of educational systems in Pakistan?
2. How can educational institutions effectively adopt and implement future trends in education?
3. What strategies are most effective in facilitating the successful integration of future trends in educational systems?

4. Literature review

Global economic shifts and technological advances, including MOOCs, mobile learning, social networking, and cloud computing, have profoundly transformed education, enhancing teaching, global accessibility, and practical exposure, ushering in a more advanced and relevant form of traditional education. E-learning platforms play a significant part in learning activities at higher education institutes. In various computer-assisted learning and teaching methods, the emphasis is laid on communication, technology, or content (Aparicio & Bacao, 2013; Dekhane & Thakur, 2018; Mason & Rennie, 2006). According to research by Liu et al. (2010), the design of an e-learning course significantly affects how beneficial and interactive the learning experience is, and overall, the learning experience is rated by students. Collaborative learning, which emphasizes interactive social processes, is an important aspect of e-learning. E-learning can be perceived as both computer-assisted learning and a pedagogical approach promoting student-centered and collaborative learning (Vanve et al., 2016).

According to the U.S. Department of Education, digital technologies can empower students to become drivers of their own learning, deeper thinkers, and stronger collaborators (U.S. Education Department, Office of Educational Technology, n.d). online course enrollments have significantly increased by 65% (U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, 2010). With online platforms like smartboards, Moodle, Edmodo, and Sakai, among others,

playing a vital role in reaching students from diverse nations and situations, open courses have also seen a significant increase in student enrollments (Allison, 2012; Aparicio & Bacao, 2013). The widespread adoption of e-learning systems has enhanced the accessibility, interactivity, and effectiveness of educational resources, transcending geographical and temporal constraints (Liu & Yu, 2023). Younas and Dong (2024) investigated the impact of animated movies (AM) on vocabulary acquisition among 12th-grade students in Lahore, Pakistan. Utilizing a controlled experiment with 64 participants, the research found that students using AMs significantly improved their English vocabulary compared to those using traditional learning methods. The findings indicated a statistically significant improvement in both receptive and productive vocabulary scores in the experimental group, demonstrating the effectiveness of animated movies in enhancing English vocabulary learning. This study contributes to understanding how animated content can support English as a Foreign Language (EFL) education.

Similarly, Noor et al.'s. (2022) study evaluated the impact of digital technologies on students' learning behaviors, motivation, and knowledge development within higher education in Lahore, Pakistan. A survey involving 300 university students analyzed using Smart-PLS and SEM confirmed that educational apps, animated movies, and virtual classrooms positively influence knowledge development and student motivation. However, the direct link between learning behavior and student motivation was not established. Overall, the research underscores the significant role of digital platforms in enhancing educational outcomes. Hakimi et al. (2024) analyzed e-learning at Afghan universities, utilizing a mixed-methods approach with 180 diverse faculty participants. It highlights adopting digital tools like Learning Management Systems and gamification while noting challenges such as content management and resistance to change. Grounded in theories like the Technology Acceptance Model, the study offers insights for educators and policymakers, acknowledging limitations like response bias and suggesting areas for future research. E-learning platforms work as instruments for streamlining communication channels and information structure among course participants, facilitating engagement between students, teachers, and other students. E-learning systems are a type of collaborative technology since this communication component facilitates interaction between students and lecturers and between students themselves (Suthers & Seel, 2012, pp. 719–722).

Early computer-based learning/training (CBL) systems, primarily used for knowledge transfer, frequently attempted to mimic authoritative teaching methods. Later methods, however, based on computer-supported collaborative learning (CSCL), encouraged the creation of knowledge collectively. The demand for rapid and efficient learning organizations has intensified. Amidst the current economic challenges, educational market competitiveness, and demographic shifts, there is a growing inclination towards e-learning across all educational levels, notably in higher education (Schulz, 2023). E-learning offers personalized learning support through information, advice, and guidance services. It assists learners in finding the most suitable courses, ensuring a seamless transition to subsequent stages of their learning journey. This includes online application or enrollment and the provision of an electronic portfolio to document their learning progress and carry it forward (Vanve et al., 2016). Similar ideas were put forth by Sharifi et al. (2014), who focused on open knowledge transfer. Schulz's (2023) study highlights the increasing favorability of e-learning in higher education amid economic, competitive, and demographic challenges. It investigates student preferences, perceptions, and future learning choices between traditional and remote methods while soliciting feedback for enhancing distance education. The study also addresses and explores the strategies of state vocational universities to adapt to the demands of digitalization. It explores the growing importance of connectivism as a teaching model, comparing it with existing paradigms and addressing its criticisms and risks.

5. Educational theories about e-learning

The Communities of Inquiry (COI) is the number one theoretical model for reading e-learning, promoting collaborative studying surroundings wherein contributors can seamlessly transition between roles of coaching and getting to know. It encourages coaching conversations that foster inquiry, facilitate means-making, and ensure knowledge comprehension. This model is constructed on three foundational elements—social presence, teaching presence, and cognitive presence—and is evaluated in various e-learning contexts regarding the usage of gear, including the COI survey (Thomas et al., 2017). meanwhile, the Theory of Acceptance Model (TAM), more regularly than not now, examines instructors' viewpoints on mixing virtual technology into educational strategies, emphasizing the significance of technology's availability and purchaser-friendliness as critical drivers of its adoption. Studies have established that those factors notably affect people's attitudes and intentions within the route of virtual generation (Rasi & Vuojarvi, 2018).

The Communities of Inquiry (COI), with its components of social presence, coaching presence, cognitive presence, and the Theory of Acceptance Model (TAM), function as essential theories in instructional studies. At the same time, as COI lays the inspiration for setting up collaborative getting-to-know companies in e-mastering settings, TAM gives insights into instructors' views on digital device utilization. The education presence consists of components like course layout and training; social presence fosters an interactive and related knowledge of experience, and cognitive presence centers on improving information through essential speech. The COI survey aids in applying this framework to evaluate these dimensions in diverse e-analyzing environments (Thomas et al., 2017).

TAM is regarded as a complementary model to COI, focusing on the perceived usefulness and ease of use of virtual technologies—factors important for technology adoption. Perceived usefulness pertains to the tangible benefits of the era at the same time as perceived; perceived ease of use refers to the simplicity of its operation. TAMs greatly affect educators' attitudes and intentions toward virtual technology integration (Rasi & Vuojarvi, 2018). Integrating TAM's insights on era adoption with COI's collaborative ideas allows for an in-depth exploration of e-getting-to-know dynamics. This synergy supports collaborative knowledge of opportunities and offers an angle on individual attitudes affecting digital technology adoption in schooling, making this framework a treasured device for the exact evaluation of e-mastering environments. The framework claims to be a reliable tool for capturing the complexities and subtleties of e-learning spaces in detail.

6. Empirical research

Empirical investigations display various effects of blended and online knowledge of modalities. An examination using Alsalhi et al. (2021) amongst dental students at Ajman University indicated that blended learning is effective in the United Arab Emirates and probably in various settings. Bumblauskas and Vyas (2021, p. pp147) tested a hit software of trouble-based learning (PBL) in a virtual postgraduate marketing program at the University of Missouri, highlighting the version's efficacy in hybrid studying contexts. Fauzi et al. (2021), on Google classroom utilization in West Sumatra during the COVID-19 pandemic, analyzed the function of the Internet getting the right of entry to and device availability, emphasizing the significance of infrastructure for E-learning knowledge of effectiveness. Jdaitawi (2020) found that flipped getting-to-know procedures led to higher knowledge of related emotion rankings among science students in Saudi Arabia, suggesting more vital educational stories. Furthermore, a survey by Karasneh et al. (2021) of Jordanian college professors' online study reviews at some point during the pandemic recognized demanding situations to its sustained adoption of publish-pandemic. They analyze factors such as internet access and

device usage to understand how these variables influence the effectiveness of using Google Classroom. This research underscores the importance of proper infrastructure for quality learning, highlighting how enabling factors play a significant role in determining the perceived usefulness and ease of use of e-learning platforms. Jdaitawi (2020) employed a quasi-experimental design to compare traditional methods with flipped learning at a Saudi institution in investigating science students' emotions and learning. The study results indicate that the flipped learning group had considerably better learning-related-emotion scores, indicating the possibility of pleasant learning experiences in science education with flipped learning.

In a survey conducted by Karasneh et al. (2021), 508 Jordanian university professors were asked about their experiences with online learning during the pandemic and what obstacles they saw to its continued use after it ended. Even while some people saw themselves as early adopters, several challenges—such as gender disparities—were brought to light, highlighting how difficult it will be to make the shift from COVID-19 to universal online learning. In an autoethnographic investigation of an Asian student's discontent with online learning in an Australian institution during the COVID-19 pandemic, Lin and Nguyen (2021) question presumptions on educational parity. The study emphasizes the importance of understanding student perspectives, particularly regarding the anxiety of online connection and considerations related to employability benefits and parental expectations.

Moreover, in a study Metruk (2020) explored Slovakian University students' attitudes toward smartphones in English as a Foreign Language (EFL) studies, revealing a generally positive perception due to their flexibility yet indicating that smartphones are not considered essential for language learning. The study underscores the potential benefits of smartphones, emphasizing the need for teachers to guide students in maximizing their usage for classroom and independent EFL studies. The analysis by Charbonneau-Gowdy et al. (2023) underscores gaps in eLearning literature, highlighting common themes in significant journals related to students' experiences, connectivity, and the value of e-learning. Meanwhile, the current study emphasizes to evaluate the critical need for investigations into emerging technologies for the e-learning environment in Pakistani universities and the perception of their faculty member in dealing with challenges arising during the adoption of e-learning trends.

7. Methodology

This study utilized a qualitative research methodology to explore global e-learning trends, specifically focusing on the perspectives of university teachers in Pakistan. Seven universities were randomly chosen from the capital territory using a random selection process. A total of 70 teachers, comprising 35 men and 35 women, were included in the sample size, with ten lecturers randomly selected from each university. Semi-structured interview questions were used for the qualitative research method to gather information from the selected population. In-depth exploration of individuals' perspectives and experiences was facilitated through one-on-one interviews. Ten instructors participated in the pilot test of the semi-structured interview questions to ensure clarity and relevance before the actual data collection process.

The reliability and trustworthiness of the findings were enhanced by a comprehensive examination of the results conducted by five teacher education experts. These professionals evaluated, scrutinized, and verified the accuracy of the results, offering valuable insights into the research. Inter-coder reliability was tested to ensure the validity of the theme analysis. An extensive audit trail was maintained throughout the analysis process to document analytical judgments, and peer review meetings were held to validate the interpretation of the themes.

Thematic analysis was utilized in this study. Braun and Clarke (2006) define thematic analysis as a qualitative research tool. This approach facilitated the identification, analysis, organization, description, and reporting of themes revealed in the data collection. Ethical

considerations were paramount during the research process. Participants provided informed consent, and measures were implemented to safeguard their confidentiality and privacy. The study's findings offer valuable information and insights into current e-learning trends as perceived by teachers in the capital territory. The study's limitations, including its specific geographical focus and sample size, are clearly articulated to provide a realistic assessment of its scope and generalizability. The research design prioritizes transparency and rigor in the data collection and analysis processes.

8. Result

8.1. Research results

The research findings show that artificial intelligence (AI) is currently the emerging trend in the evolution of the educational system. University teachers believe that their lives are being increasingly impacted by artificial intelligence. AI advancements make it possible to reuse course contents, which lower the amount spent on content production. By offering adaptable content and tests catered to the needs of specific students, artificial intelligence can facilitate individualized learning. "*Gamification is a current trend as well.*" The learning environment has altered due to the employment of role-playing games and other learning technologies. Playing games is frequently pleasurable and can foster critical social interaction abilities. When we win a game, we always feel a sense of success. Building self-esteem through mastering problem-solving skills and winning tactics also advances cognitive learning. Gamification incorporates game aspects that inspire students and encourage their achievement, making learning enjoyable and engaging. "*Mobile learning is another well-known trend that enables real-time interaction with pupils.*" More people may now use e-learning platforms since smartphones, tablets, and other mobile devices are becoming more widely available and affordable.

Mobile learning promotes self-directed learning and offers convenience and flexibility by enabling students to access learning materials whenever and wherever they choose. The information presented in educational programs must be both interesting and pertinent. With the use of quickly digestible informational pieces like video-based lessons, interactive movies, quick games, and quizzes, schools can provide just-in-time education. Delivering bite-sized, targeted learning content to address specific learning objectives is known as micro-learning. It is

Table 1

Future trends in the development of educational systems in present-day situations.

Educational Trends	Description
Artificial Intelligence (AI)	AI advancements facilitate individualized learning, reusing course content, and offering adaptable content tailored to specific student needs.
Gamification	Incorporating game aspects in education enhances engagement, fosters critical social interaction skills, and promotes cognitive learning through enjoyable game-based experiences.
Mobile Learning	Mobile learning, enabled by smartphones and tablets, promotes self-directed learning, flexibility, and convenience by allowing real-time interaction with educational materials.
Micro-Learning	Bite-sized, targeted learning content, delivered through video-based lessons, interactive movies, and quizzes, provides flexible, accessible, and personalized learning experiences.
Video-Based Learning	Video-based learning is integral to online and physical learning. It allows dynamic and interactive instruction and fosters remote access to educational materials through visual content.
Collaboration and Social Learning	Building online communities and collaborative learning environments empowers students to share knowledge, enhancing critical thinking and communication skills.

Table 2

Implementation focus area.

Implementation Focus Area	Description
Strategic Planning	Prioritize strategic planning to adopt future trends by aligning institutional goals, resources, and initiatives with emerging educational advancements. This involves identifying key performance indicators (KPIs), setting clear objectives, and allocating resources effectively to support the integration of new technologies.
Faculty Development	Invest in professional development for educators to equip them with the necessary skills and knowledge to seamlessly integrate and effectively utilize future trends. This includes offering workshops, continuous training programs, and access to online resources to increase teachers' teaching strategies and technological competencies.
Infrastructure Investments	Allocate resources for technological infrastructure improvements, ensuring the institution can support and sustain the implementation of evolving educational trends. This covers upgrading software and hardware, improving internet connectivity, and ensuring technical support is readily available for smooth operation.
Artificial Intelligence Integration	Effective AI integration demands educator training, AI-supported platforms, and adaptive content for personalized learning. For creating personalized learning experiences, teachers should be trained to use AI tools and institutions should invest in AI platforms that can analyze student data and provide learning pathways.
Gamification Adoption	Adopting gamification involves integrating game elements into curriculum design, fostering a positive learning environment, and providing training on gamified instructional techniques. This strategy aims to increase student engagement and motivation by incorporating elements such as point scoring, leaderboards, and badges into learning activities.
Mobile Learning Implementation	Effectively implement mobile learning by ensuring technological infrastructure supports integration, providing mobile-friendly content, and offering training for educators on mobile teaching methods. This ensures that learning materials are accessible on various mobile devices, enabling students to learn anywhere.
Micro-Learning Implementation	Implement micro-learning by designing modular content, incorporating interactive elements, and promoting a culture of continuous learning within the educational institution. Micro-learning involves breaking down content into small, manageable units that can be easily consumed in short time frames, making learning more flexible and accessible.
Video-Based Learning Implementation	Successfully implement video-based learning by investing in recording and editing tools, creating engaging video content, and ensuring accessibility for diverse learners. This includes producing high-quality educational videos, providing transcripts or subtitles, and making videos available on various platforms for easy access.
Collaboration and Social Learning Implementation	Foster collaboration and social learning by building online communities, nurturing a collaborative culture, and training educators to facilitate social learning experiences. This includes creating virtual spaces where students can interact, collaborate on projects, and share knowledge and training teachers to manage and support these interactions effectively.

appropriate for just-in-time learning because it provides flexibility, simple accessibility, and personalized learning experiences. Another upcoming trend is video-based learning. The use of videos has become an integral part of online learning as well as physical learning. Video-based learning allows for dynamic and interactive instruction, enabling students to access educational materials remotely and engage with visual content. Collaboration and social learning are two concepts that are getting more and more attention in eLearning. Educators can encourage students to share their knowledge and experience and learn from their peers by building online communities and collaborative learning environments. Students who collaborate and share knowledge while gaining from peer interactions develop their critical thinking and communication skills. Overall, these trends can empower students, increase their engagement, and provide personalized learning opportunities that cater to diverse learning styles and preferences, as mentioned in the following Table 1.

To adopt and implement future trends effectively, educational institutions should prioritize strategic planning, faculty development, and infrastructure investments. Integrating Artificial Intelligence requires professional development for educators, establishing AI-supported learning platforms, and creating content adaptable to individual learning needs (Imran et al., 2024). Gamification adoption involves incorporating game elements into curriculum design, creating a positive learning environment, and training educators on gamified instructional techniques. For mobile learning, institutions must ensure that technological infrastructure supports seamless integration, provides mobile-friendly content, and offers training for educators on mobile-based teaching methods. Implementing micro-learning involves designing modular content, utilizing interactive elements, and promoting a culture of continuous learning. Video-based learning necessitates investing in recording and editing tools, creating engaging video content, and ensuring accessibility for diverse learners. Collaboration and social learning implementation require building online communities, fostering a collaborative culture, and training educators to facilitate social learning experiences. The following Table 2 presents the implementation focus areas.

Successful integration of future trends demands a holistic approach involving policy development, faculty support, and a student-centered focus. Developing clear policies and guidelines for the ethical use of AI in education is crucial, ensuring transparency, privacy, and equity. Establishing a robust support system for educators, including training programs and resources, is essential for effectively implementing gamification, mobile learning, and other trends. Implementing a comprehensive technological infrastructure with user-friendly interfaces is critical for seamless integration. A pedagogical shift towards active, student-centered learning strategies is imperative for micro-learning, video-based learning, and collaborative approaches. Employing frameworks that promote accessibility, diversity, and inclusion ensures that educational systems cater to the needs of all learners. According to the integration area description in Table 3, the continuous assessment and feedback mechanisms help refine and optimize the integration of these trends over time, ensuring sustained improvement and relevance in educational systems.

All the above discussions are simulated by the artificial intelligence tool using a Fuzzy Interface System. A fuzzy-based system is proposed for learning assessment, as shown in Fig. 1. The assessment of learning quality is done using possible suitable parameters. By water elements characteristics, the expert system is divided into multiple layers, which present the complete structure of the proposed method shown in Fig. 2. The parameters include AI integration, video creation, collaborative culture, mobile learning, equal access, gamification training, and micro-learning. Using these parameters, authors assess learning quality, as shown in Figs. 2 and 3.

The values of AI Integration, Video creation, Collaborative Culture, Mobile learning, Equal Access, Gamification Training, and Micro-Learning parameters are also used to build up a lookup table as shown in Table-1Micro-Learning parameters are also used to build up a lookup Table, as shown in Table 1. In the proposed system, seven input parameters are used to assess the learning quality mathematically, which can be written as

$$\mu_{A \cap B \cap C \cap D \cap E \cap F \cap G \cap H}(a,b,c,d,e,f,g,h) = \min[\mu_A(a), \mu_B(b), \mu_C(c), \mu_D(d), \mu_E(e), \mu_F(f), \mu_G(g), \mu_H(h)] \tag{1}$$

8.2. Input fuzzy sets

The statistical values of fuzzy input variables are used to assess the learning quality. After a discussion with an expert, the numerical values are divided into 'No' and 'Yes'. Table 4 describes all input variables with their numerical values.

The following Fig. 4 shows the learning criteria for multiple parameters, such as AI Integration, Video Creation, etc. The yellowish shade shows excellent learning. Learning is satisfactory (Greenish Shade). The blueish shade shows excellent learning.

However, the following Fig. 5 further describes whether AI Integration is yes, Video creation is yes, Collaborative Culture is No, Mobile learning is No, Equal Access is No, Gamification Training is No, and the output layer (Learning) is very Low. The Fuzzy system shows that modern tools and techniques are important for good-quality learning (see Fig. 6).

9. Discussion

Modern e-learning trends in education catalyze transformative shifts, revolutionizing traditional learning paradigms with innovative technologies and pedagogical approaches. Embracing these trends can enhance educational effectiveness by adapting pedagogical approaches to current needs. Bozkurt et al. (2015) highlighted critical themes from 2009 to 2013, emphasizing open education, resources, and the significance of instructional design in e-learning, which involves systematically translating learning principles into practical solutions and addressing identified issues.

The primary research goal was to identify present and upcoming trends in educational systems. Integration of future trends in education necessitates a complete strategy from educational institutions, focusing on strategic planning, faculty development, and infrastructure investments. In particular, the study underlines the rising significance of artificial intelligence (AI) in e-learning, reflecting the findings of (Roll & Wylie, 2016), which confirm AI's potential for significant breakthroughs in education. According to Seo et al. (2021), artificial intelligence (AI) systems are important in improving online learning and teaching by providing tailored learning experiences for students, automating

mundane work for instructors, and enabling adaptive evaluations. Despite the intriguing opportunities given by AI, its impact on the cultural dynamics, norms, and expectations that govern interactions between students and instructors remains unknown.

In online learning, the contact between students and instructors, which includes communication, assistance, and presence, substantially impacts student satisfaction and learning results. Video-based learning is also highlighted, consistent with Teoh et al.'s (2022) emphasis on the efficacy of ensemble approaches in improving educational results in video-based learning environments. Video-based learning has been acknowledged for improving student engagement and comprehension through visual and auditory cues, resulting in a more dynamic teaching experience. Sablic, Mirosavljevic, and Skugor's (2021) research highlights the rapid advancement of video technology in education, fueled by the extensive use of mobile devices, an increasing number of internet users, and massive online open courses.

Online learning films, sound valued for their numerous sound effects, are gaining popularity among experienced students and professors. Aside from assisting students in their learning journeys, video-based learning is an effective tool for teachers. It serves as a source of support and a vital asset in their professional growth. Social learning and collaboration are critical trends, in line with Grabinger & Dunlap's (2017) emphasis on information sharing, peer learning, and student teamwork. According to research, combining social learning platforms and collaborative technology can allow students to engage, share ideas, and learn from one another in natural and virtual environments. According to Krull and Duart (2017), mobile learning is a notable trend because of its flexibility and ease.

The study acknowledges mobile devices' potential for providing students with access to educational resources, fostering communication, and facilitating tailored learning experiences. However, the study underlines the existing problems of connectivity and device compatibility, which must be solved to enable fair access to mobile learning possibilities. Subsequent publications in the IRRODL journal 2018 focused on scientific debates of learners, collaborative and self-paced learning, engagement, and mobile device use.

In line with (Becheru et al., 2018), teachers strive to comprehend students' collaboration patterns, employing techniques like social

Table 3
Integration area.

| Integration focus area	Description
Policy development for AI in education	Develop clear policies and guidelines for the ethical use of AI in education, emphasizing transparency, privacy, and equity. This involves setting standards for AI deployment, promoting fair access to AI technologies, and ensuring data protection. Establishing ethical frameworks and compliance measures is crucial to addressing possible biases and misuse of AI.
Faculty support system	Establish a robust support system for educators, including comprehensive training programs and resources, to implement trends effectively. This support system should offer technical assistance, continuous professional development, and peer collaboration opportunities to help teachers integrate pedagogical methods and new technologies into their teaching practices.
Technological infrastructure integration	Implement a comprehensive technological infrastructure with user-friendly interfaces to integrate emerging educational trends seamlessly. This includes investing in reliable internet connectivity, modern hardware and software, and providing technical support to ensure all educational technologies function smoothly and efficiently within the institution.
Pedagogical shift to student-centered learning	Foster a pedagogical shift towards active, student-centered learning strategies, such as successfully implementing micro-learning, video-based learning, and collaborative approaches. This involves redesigning curricula to focus on interactive and participatory learning experiences, training educators in these methods, and continuously assessing and refining teaching strategies to enhance student engagement and learning outcomes.
Accessibility, diversity, and inclusion frameworks	Employ frameworks that promote accessibility, diversity, and inclusion to ensure educational systems cater to the needs of all learners. This includes implementing assistive technologies, developing inclusive curricula, fostering an inclusive environment, and ensuring compliance with accessibility standards that respect and value diverse perspectives and backgrounds.
Continuous assessment and feedback mechanisms	Implement continuous assessment and feedback mechanisms to refine and optimize the integration of trends, ensuring sustained improvement and relevance. This involves using formative and summative assessments to gather data on student performance, incorporating feedback from students and educators, and making data-driven decisions to improve educational practices and outcomes. It is important to regularly update assessment tools and techniques to align with current educational trends and technologies.
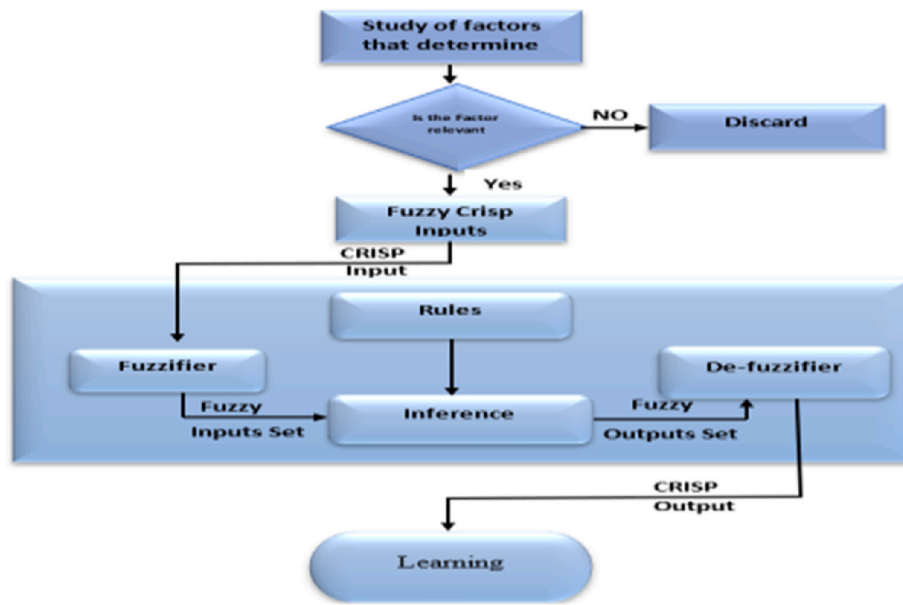
Fig. 1. Data flow diagram.
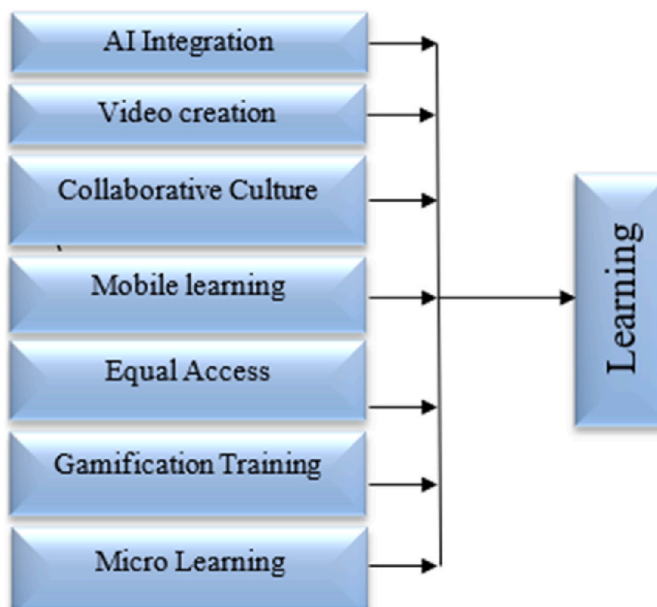
Fig. 2. Parameters.

network analysis and network visualizations to gain insights into the dynamics of social interactions among learners. Gamification was recognized as a prominent trend in the present study, aligning with the positive impacts on student engagement, motivation, and learning outcomes explored by (Kocakoyun & Ozdamli, 2018). Contributing incorporating game elements, such as leaderboards, badges, and rewards, is acknowledged as a strategy for enhancing student motivation and fostering an interactive and enjoyable learning experience while also contributing to developing collaborative, problem-solving, and critical thinking abilities. Microlearning emerges as another noteworthy trend, aligning with the insights provided by (Megawati & Trisnawati, 2022). Adopting bite-sized learning modules addresses learners' just-in-time needs, allowing educators to present information in manageable chunks and supporting reinforcement, review, and on-demand learning, ultimately enhancing learners' ability to acquire and retain knowledge more effectively (Table 1). Another research problem concerns how

educational institutions can adopt and implement these trends effectively. The study underscores the importance of prioritizing strategic planning for educational institutions to effectively adopt and implement emerging trends. Conclusive outcomes highlight the deliberate focus on strategic planning, as elucidated by (Priyambodo & Hasanah, 2021). Recognizing the imperative to enhance the quality of education to meet the diverse requirements of schools and communities, strategic planning emerges as a transformative initiative. It positions schools as dynamic hubs committed to advancing the overall quality of education. The research further reveals the significance of targeted faculty development initiatives, aligning with the perspectives of (Guraya & Chen, 2019). Faculty vitality is crucial for advancing professional education, enriching key domains such as teaching, assessment, research, professionalism, and administration, significantly contributing to learners' academic performance. Faculty development programs are acknowledged as standalone pedagogies, playing a vital role in fostering knowledge and professional skills among faculty members. Additionally, the study emphasizes the need for substantial investments in robust infrastructure by educational institutions. This strategic investment is deemed essential for creating an environment conducive to the effective implementation of future trends in education, as highlighted by the research findings (Table 2).

The research conducted by Machusky and Herbert-Berger (2022) illuminates the significance of technology dependency among students and teachers during school closures. This dependency underscores the efficacy of eLearning technologies in specific areas while also pinpointing aspects needing refinement in their design and implementation. The third research problem concerned the most effective strategies for successfully integrating these trends into educational systems.

The findings highlight the crucial need for educational institutions to adopt clear and comprehensive policies addressing the integration of artificial intelligence. Building on the insights presented by (Pedro et al., 2019), the budding discipline of Artificial Intelligence is recognized for its revolutionary potential across a wide range of social interactions. AI is actively contributing to developing innovative teaching and learning solutions in education, which are currently being evaluated in various settings. The report highlights that such improvements require superior infrastructures and the development of a robust ecosystem of innovators to allow AI's seamless integration and evolution in education.

The research findings highlight the crucial relevance of educational institutions focusing on constructing specialized faculty support
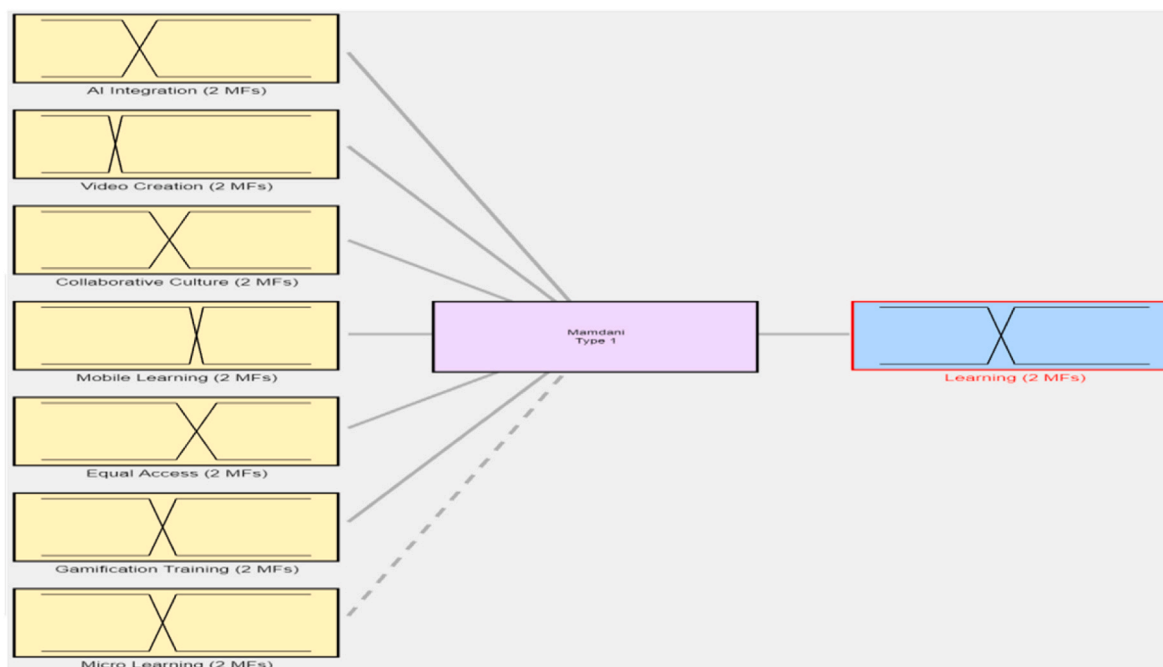
Fig. 3. Mamdani type.

Table 4
Numerical values of input variables.

Learning		
Properties/Parameter	No	Yes
AI Integration (AI)	$0 - 23$	≤ 10
Video Creation (VC)	$0 - 30$	≤ 25
Collaborative Culture (CC)	0-55	≤ 40
Mobile Learning (ML)	$0 - 60$	≤ 55
Equal Access (EA)	$0 - 65$	≤ 50
Gamification Training (GT)	$0 - 50$	≤ 40
Micro-Learning (MiL)	$0 - 40$	≤ 30

systems, as Miller et al. (2009) suggested. Faculty members from traditional university settings may struggle to adapt to the unique needs of online learners, as they sometimes lack the resources required for effective education. Addressing the shift to virtual classrooms requires proactive engagement and collaboration among professors and staff to improve the student experience. This study emphasizes the importance of educational institutions prioritizing the development and implementation of strong support systems in order to ensure faculty readiness and improve the overall efficacy of online learning environments.

The research outcomes underscore the imperative for educational institutions to augment their technological infrastructure. Drawing on the insights of (Florida, 1995), in the era of global, knowledge-intensive capitalism, regions are emerging as vital hubs for knowledge creation and learning, evolving into dynamic learning regions. These regions function as centers that accumulate and store knowledge and ideas, providing the necessary environment and infrastructure to facilitate the seamless flow of knowledge, ideas, and learning. Furthermore, the study results emphasize the need for educational institutions to shift towards purposeful student-centered learning. As highlighted by (Wright, 2011), student-centered approaches play a transformative role in altering power dynamics, actively engaging learners with course content, and fostering shared responsibilities for learning. This approach emphasizes holistic understanding within the evaluation process. The research advocates for a strategic focus on enhancing technological infrastructure and a deliberate transition towards student-centered learning as critical imperatives for educational institutions seeking to adapt and thrive in the evolving landscape of education.

10. Conclusion

The study examines emerging e-learning trends through faculty perspectives and offers significant insights into the integration and impact of technologies like artificial intelligence, video-based learning, social collaboration, mobile learning, gamification, and micro-learning. By employing a fuzzy inference system in MATLAB, which demonstrated high accuracy, this research underscores the feasibility of advanced computational methods in educational assessments and enhances the understanding of how these technologies can be leveraged to improve engagement and learning outcomes. Importantly, it bridges a gap in existing scholarship by providing empirical evidence on the effectiveness of strategic planning and faculty development in adopting e-learning innovations. Additionally, this study contributes to the ethical discourse surrounding technology use in education, offering guidelines for responsible integration to ensure inclusivity and fairness. The authors systematically investigated the contemporary educational landscape, highlighting pivotal trends such as artificial intelligence, gamification, mobile learning, video-based learning, micro-learning, and collaboration/social learning. The effective adoption of these trends within educational institutions requires a strategic focus on key areas. The findings advocate for the transformative potential of e-learning technologies to create dynamic educational environments, enriching the digital education literature and offering practical insights for policymakers and educators. Future studies should further investigate the long-term effects of these e-learning strategies and their scalability across different educational contexts. The significant achievements of this study include focusing on strategic planning, targeted faculty development programs, and significant investments in robust infrastructure. Notably, integration techniques include developing explicit regulations for artificial intelligence, implementing dedicated faculty support systems, improving technical infrastructure, and deliberately moving toward student-centered learning. When implemented thoroughly, these strategies help to ensure the successful implementation of future trends, resulting in a dynamic and inclusive educational environment that responds to learners' different requirements.
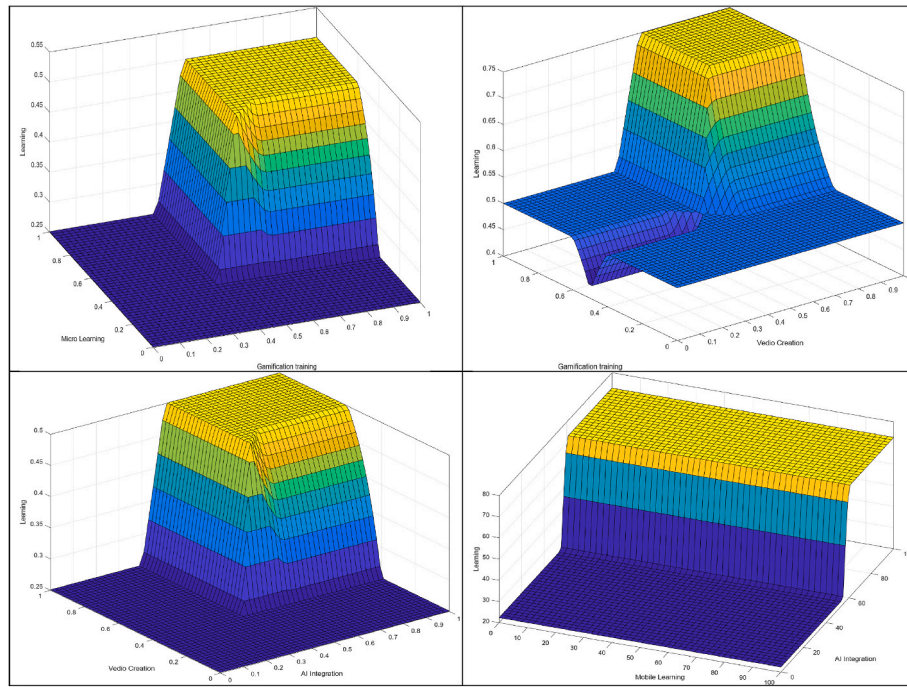
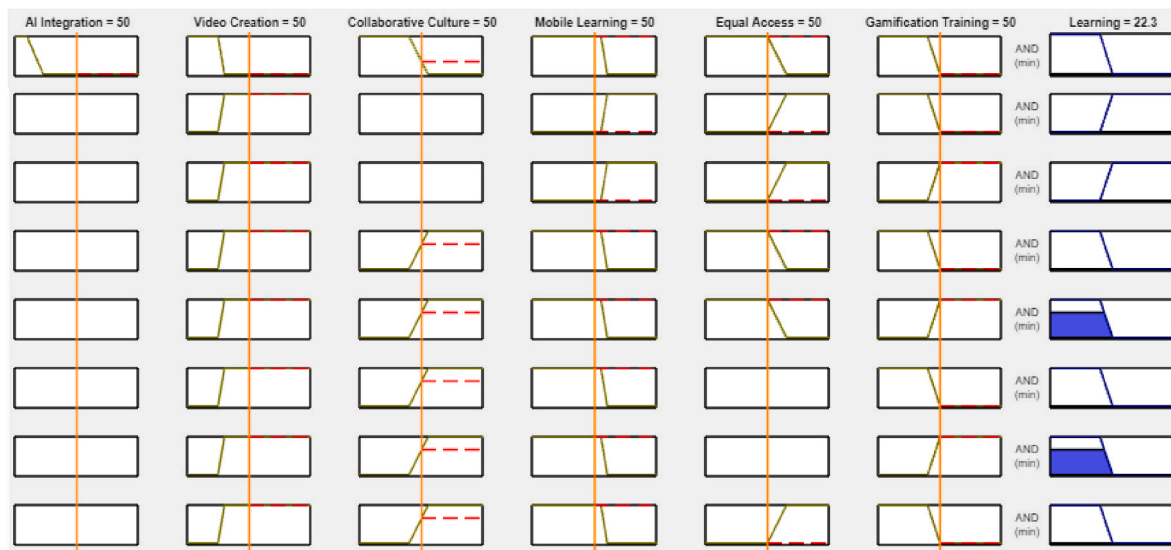**Fig. 4.** Rules Surface of learning quality based on different parameters.

Fig. 5. Output Layer, Lookup diagram of low learning.

Recommendations

It ends with pointers for educators, legislators, and e-mastering practitioners primarily based on the findings. These tips will try to lead destiny traces of inquiry, influence coaching strategies, and deal with the changing demands and difficulties in getting to know.

1. Encourage teachers to research and use AI-based structures that provide adaptive critiques and individualized guidance. Offer specialized training classes emphasizing real-time feedback and practical packages for incorporating AI into lesson plans (Jabeen, 2023).
2. Lead realistic seminars where educators can learn efficient strategies for growing films. Placed your interest in potential processes that enhance student knowledge and engagement. Offer sources, like enhancing tools and templates, that make the video system less complicated.
3. Encourage collaborative surroundings inside the study room by implementing online boards, institution projects, and virtual groups. Outline the regulations for efficient teamwork and peer-gaining knowledge and offer assets for collaboration.
4. Support educators in developing lesson plans that employ college students' cell gadgets for communication, studies, and creative expression. Ensure that each student has equitable access to the net and cellular gadgets. Teach teachers a way to integrate mobile gadgets into lesson plans in a green manner. Placed policies in the vicinity guarantee that each student has equitable entry to mobile devices and net connectivity. Provide teachers with possibilities for expert development to become specialists in gamification, which makes getting to know more exciting and attractive.

Fig. 6. Recommendations.

5. Create and choose microlearning materials for self-paced gaining knowledge that students can use on their personal. Those substances must be clean, simple, and consistent with sure getting-to-know dreams.

6. Motivate educators to incorporate microlearning sports into combined mastering techniques readily. Give templates and examples of how to upload microlearning into already-present lesson plans, highlighting its function in reiterating crucial ideas.

By implementing these recommendations, instructional institutions and instructors can better use mobile studying, gamification, social learning and collaboration, synthetic intelligence, video-primarily based getting to know and micro-getting to know to create engaging and effective learning environments.

Limitations of the study

Observing modern-day e-learning knowledge of tendencies within the academic landscape gives precious insights. It is essential to renowned various techniques. The geographical cognizance exclusively on teachers from the universities of Rawalpindi and Islamabad areas in Punjab, Pakistan, may restrict the generalizability of the findings to broader academic contexts. Despite efforts to ensure variety, the exceptionally small sample size of 70 instructors might not fully seize the various views and reviews widely spread in different regions. The qualitative method, counting on semi-dependent interviews, introduces subjectivity and might not represent the views of all educators. Time constraints are noteworthy, given the speedy evolution of generation, potentially rendering the observer's findings much less applicable as more modern traits emerge. The cultural context of Punjab may additionally influence the applicability of the findings in distinct cultural and educational settings. Ethical issues, bias, and postulation compete as the teaching and learning process prerequisite. Conceding these limitations is pertinent for the study's outcome and leads to new perspectives for the imminent research on similar areas.

Ethical statement

This study has been approved by the ethical committee of the University of Education. Before the interviews, all participants gave written consent online.

CRediT authorship contribution statement

Muhammad Adnan Maqbool: Writing – original draft, Visualization, Data curation, Conceptualization. **Muhammad Asif:** Visualization, Validation, Software, Investigation, Formal analysis. **Muhammad Imran:** Writing – original draft, Visualization, Validation, Methodology, Funding acquisition, Formal analysis. **Sunble Bibi:** Writing – review & editing, Validation, Software, Resources, Formal analysis, Data curation. **Norah Almusharraf:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Funding acquisition.

Declaration of competing interest

The authors declare that there is no financial or any other conflict of interest associated to this study.

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