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Strategies for enhancing the quality of virtual education: perspectives of medical sciences faculty and students - a qualitative study

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Abstract

Background Virtual education has gained prominence in medical sciences, introducing new challenges in student training. It is therefore essential to identify strategies ensuring virtual education effectively equips medical students with requisite knowledge and skills. This study aimed to explore strategies for improving virtual education quality from the perspectives of medical sciences faculty and students.

Methods This qualitative study employed conventional content analysis. Participants included 11 faculty members and 54 medical sciences students selected through purposive sampling. Data were collected via semi-structured individual and focus group interviews and analyzed using the Graneheim and Lundman method.

Results The findings revealed two main categories: instructor-related strategies, including regular and scheduled teaching, engaging content design, alignment with in-person learning, effective virtual assessment, standardized assignments, active student engagement, and constructive interaction with students; and managerial/organizational strategies, including monitoring faculty teaching quality, empowering faculty members, supporting low-income students, and improving infrastructure.

Conclusion Enhancing virtual education quality requires a multifaceted approach addressing both instructor-related and organizational dimensions. Implementing these strategies can foster more effective and inclusive virtual learning environments in medical education.

Keywords Medical education, Virtual learning, Quality improvement, Educational strategies, Qualitative research

Background

Virtual education encompasses instruction conducted outside traditional face-to-face settings. Learners engage through web-based platforms, with content delivered via videos, interactive media, or broadcast technologies [1]. This approach supplements conventional programs

by leveraging internet capabilities to provide equitable information access irrespective of learners' geographical, social, or economic circumstances [2].

Virtual education offers advantages including accessibility, flexibility, and enhanced interdisciplinary collaboration [3, 4]. A systematic review by Eslami et al. [5] indicated virtual education often equals or exceeds traditional methods in effectiveness, with high satisfaction reported among stakeholders.

Despite the benefits of virtual education, there are challenges such as technological barriers, reduced practical and clinical experiences, psychological impacts, and

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assessment limitations [6–9]. Among these, technological barriers represent one of the most significant obstacles in virtual medical education. Many students lack access to stable internet connections and appropriate hardware, which hinders their ability to participate effectively in online classes [9]. For instance, a study by Dost et al. found that 30% of medical students identified poor internet connectivity as a major barrier to their online learning experience [6].

Medical education heavily depends on practical training and clinical experiences, which are challenging to replicate in a virtual setting. Face-to-face interactions with patients and hands-on laboratory sessions are critical for the development of clinical skills and competencies [7, 10]. Longhurst et al. [8] documented concerns regarding diminished skill acquisition when in-person clinical training is unavailable. Although virtual simulations and online resources offer valuable support, they cannot fully substitute for the experiential learning acquired through direct patient interactions and hands-on practice [11].

Virtual education in the medical sciences has undergone a profound transformation in the post-pandemic era. The COVID-19 pandemic acted as a global catalyst for the rapid adoption and innovation of virtual medical education, leading numerous recent studies to investigate its implications and evolving practices [12, 13]. However, the abrupt transition to virtual learning has also exerted significant psychological effects on medical students. Prolonged screen time, social isolation, and the pressure to adapt to unfamiliar learning modalities have contributed to heightened levels of stress and anxiety [7, 11]. Moreover, assessing medical students' knowledge and skills within a virtual framework poses substantial challenges. Traditional assessment methods, such as practical examinations and in-person evaluations, are difficult to replicate effectively in an online environment [14]. Assessing medical students' knowledge and skills within a virtual framework presents substantial challenges. Conventional assessment methods such as practical examinations and in-person evaluations are difficult to replicate effectively online [14]. Limitations inherent to online assessments include inadequate monitoring of students during examinations and difficulties in evaluating practical competencies virtually [15]. These challenges underscore the need for innovative assessment strategies that maintain the rigor and reliability essential to medical education [10].

Recent reviews have highlighted that although emergency remote teaching initially encountered significant challenges, subsequent refinements have resulted in improved pedagogical designs, innovative uses of virtual simulations, and more effective strategies for engaging learners [16–18]. Furthermore, emerging literature indicates that hybrid models combining virtual and

in-person components are increasingly recognized for their effectiveness in maintaining educational quality while fulfilling the essential requirements for clinical skill development [19].

Building on these findings, recent research highlights a growing shift toward hybrid or blended learning models as the most likely future of education, aiming to leverage the advantages of both virtual and in-person instruction [20]. The effectiveness of these models depends entirely on intentional instructional design, comprehensive faculty development, robust technological infrastructure, and ongoing evaluation informed by stakeholder feedback [9]. Increasingly, studies underscore the necessity for a dedicated quality framework tailored specifically to virtual and hybrid medical education—one that extends beyond basic satisfaction surveys to rigorously assess learning outcomes, skill acquisition, professional identity formation, and the long-term effects on career development [20, 21].

Despite the expanding body of literature on virtual education in the medical sciences, most previous studies have primarily focused on evaluating its effectiveness, identifying technological barriers, and assessing the satisfaction of students and faculty members [5–9]. However, there remains a noticeable research gap regarding the comprehensive exploration of practical strategies specifically designed to enhance the quality of virtual education from the perspectives of both medical sciences faculty and students [6, 22]. Moreover, existing studies have seldom addressed instructor-related and managerial or organizational strategies in a systematic and integrated manner. Therefore, this study aims to address this gap by providing a qualitative exploration of strategies to improve the quality of virtual education, with particular emphasis on the context of medical sciences education.

Given the inherent challenges of virtual medical education, it is essential to identify effective strategies to overcome these obstacles and ensure that virtual education equips medical students with the necessary knowledge and skills. Accordingly, this research sought to identify strategies for enhancing the quality of virtual education from the perspectives of medical sciences faculty and students.

Methods

Study design and participants

This study employed a qualitative content analysis approach conducted between February and June 2024. The participants consisted of 11 faculty members and 54 medical sciences students from Saveh University of Medical Sciences, a public university located in Markazi Province, Iran. The university offers programs in medicine, nursing, and various paramedical and health-related

fields, admitting approximately 800 students annually through a nationwide entrance examination.

Faculty members were recruited via email invitations distributed through the university's official communication channels, specifically targeting those with at least one semester of online teaching experience. Students were invited through announcements posted on the university's virtual learning platform and shared via student messaging groups. Each invitation clearly described the study's objectives, expected time commitment, eligibility criteria, and the voluntary nature of participation. The invitations also emphasized the potential benefits of contributing to research aimed at improving online education practices and assured participants of the confidentiality and anonymity of their responses. Interested individuals contacted the research team and were screened for eligibility.

Inclusion criteria encompassed faculty members who had taught virtually for at least one semester and students who had completed a minimum of one semester of online learning. Exclusion criteria included individuals without virtual education experience or those who declined to provide consent for recording or participation.

Participants were selected through purposive sampling until data saturation was achieved, ensuring the inclusion of diverse perspectives from various medical science disciplines (e.g., nursing, anesthesia, operating room, public health, emergency medicine, health information technology, and midwifery). To enrich the data, participants with varied characteristics—including different semesters, specialties, GPAs, ages, and genders—were purposefully sampled, as this approach is well-suited for obtaining rich data in qualitative research [18]. The demographic characteristics of the participants are presented in Table 2.

Data collection

Data were collected through semi-structured, in-depth interviews conducted both individually and in groups. In total, 11 individual interviews were held with faculty members, and seven focus group interviews were conducted with 54 students. Each focus group consisted of 7 to 8 participants. The interviews lasted between 45 and 90 min, with an average duration of approximately 60 min. At the start of each interview, the interviewer explained the research objectives and assured participants of the confidentiality of their responses. Audio recordings were obtained with participants' consent.

Interviews began with broad, open-ended questions and were then adapted based on participants' responses. For example, participants were asked: "Based on your experiences with virtual education, how would you evaluate its quality?"; "To what extent do you believe virtual education has been effective for medical students?"; "What do you consider to be the criteria for high-quality

virtual education?"; "Under what conditions can virtual education be successful?"; and "What strategies would you recommend for improving the quality of virtual education in medical sciences?"

The interview guide was developed by the researchers in alignment with the study's objectives. To ensure content validity, the questions were reviewed by five experts in virtual and medical education, whose feedback was used to refine and improve the interview guide.

Data collection and participant recruitment continued until data saturation was reached, defined as the point at which no new themes, categories, or significant codes emerged from the interviews. Saturation was achieved after the seventh focus group interview with students and the eleventh individual interview with faculty members. In qualitative content analysis, the appropriate sample size is determined not statistically, but by the concept of data saturation and the richness of the collected data [23, 24].

Data analysis

Data analysis was conducted concurrently with data collection using the conventional qualitative content analysis approach proposed by Graneheim and Lundman. This method was chosen for its suitability in inductively identifying categories and themes directly from raw interview data, without imposing predefined theoretical frameworks [23].

Immediately after each interview, audio recordings were transcribed verbatim. The transcripts were reviewed multiple times to gain a comprehensive understanding of the data. The analytical process followed systematic steps:

1. Familiarization: Each transcript was read repeatedly alongside the audio recordings to ensure accuracy and immerse the researchers in the data.
2. Meaning Unit Identification: Text segments conveying distinct meanings relevant to the research objectives were identified as meaning units.
3. Condensation and Coding: Meaning units were condensed without losing their essence and labeled with initial codes.
4. Categorization: Similar codes were grouped based on conceptual similarity to form subcategories.
5. Theme Development: Related subcategories were merged into broader categories representing overarching themes [23].

In total, 154 initial codes were extracted from the transcripts. These were consolidated into 11 subcategories and further organized into two main categories: instructor-related strategies and managerial/organizational strategies. The entire coding process was performed

manually by the research team without the aid of qualitative analysis software. Both researchers independently coded the transcripts and resolved discrepancies through discussion, ensuring analytical rigor and consistency. Manual coding allowed for closer engagement with the data, facilitating more contextualized and nuanced interpretation.

To enhance transparency and reproducibility, Table 1 presents illustrative examples of the coding process, demonstrating how raw data were transformed into codes, subcategories, and main categories.

Rigor and trustworthiness

To ensure the validity and reliability of the qualitative data, Guba and Lincoln’s criteria—credibility, dependability, transferability, and confirmability—were applied [25]. Credibility was enhanced through member checking, whereby after each interview, a summary of the main points was presented to participants for clarification and verification. Additionally, transcribed interviews and extracted codes were shared with participants to confirm the accuracy of the researchers’ interpretations, and revisions were made as necessary. Triangulation of analysts was also employed by involving multiple researchers in the coding and analysis process to reduce individual bias and enrich interpretation.

To ensure dependability, all stages and procedures of the study were thoroughly documented and reported, facilitating auditability and replication. For transferability, participants’ quotes were presented verbatim. Confirmability was supported by having a second researcher review the entire dataset—including transcripts, codes, and category classifications—to ensure accurate representation of participant perspectives.

Moreover, peer debriefing sessions were conducted throughout the data analysis phase, during which external qualitative research experts reviewed emerging themes and critically assessed the interpretations to enhance the objectivity and depth of the findings. Researcher reflexivity was practiced by maintaining a

reflective journal to acknowledge and mitigate personal biases throughout the study.

Ethical considerations

This study received ethical approval from Saveh University of Medical Sciences under the code IR.SAVEHUMS.REC.1399.021. The researchers adhered to the principles of the Helsinki Declaration and international ethical guidelines for research throughout all stages of the study. Participation was voluntary, and all participants provided written informed consent for both participation and audio recording. Interview transcripts were prepared verbatim based on participants’ statements, which were reported anonymously to ensure confidentiality.

Results

The demographic characteristics of the participants are summarized in Table 2.

Table 2 presents demographic details of the study participants, illustrating a diverse sample of faculty members and students across various medical science disciplines. The study included a total of 65 participants—11 faculty members and 54 students—from multiple fields within medical sciences. Among the faculty members, 54.5% were female and 45.5% male, while the student group consisted of 53.7% females and 46.3% males, indicating a relatively balanced gender distribution.

Participants represented a wide range of disciplines, including nursing, emergency medicine, operating room, anesthesia, health information technology, environmental health, occupational health, public health, and midwifery, ensuring a rich diversity of academic backgrounds.

The mean age of faculty members was 43.2 years (SD=5.4), with an average teaching experience of 9.92 years. Student participants had a mean age of 21.45 years (SD=4.35) and an average GPA of 16.89 (out of 20), reflecting a spectrum of academic performance. This demographic diversity contributed to the richness of perspectives on virtual education, enhancing the depth, comprehensiveness, and credibility of the study findings.

Table 1 Examples of the coding process from Raw data to main categories

Participant Quote (Raw Data)	Code	Subcategory	Main Category
Instructors should regularly upload a manageable amount of material on specific dates...	Lack of regular scheduling	Regular and Scheduled Teaching	Instructor-Related Strategies
They should give students the course schedule in advance and stick to it...	Need for structured planning		
We don't know when new material is uploaded. It's confusing and stressful...	Irregular content upload	Engaging Content Design	
Instructors should regularly upload a manageable amount of material on specific dates, instead of waiting a long time and then posting everything at once...	Designing engaging content		
The videos should be short and to the point. Long ones are tiring....	Need for concise instructional videos		
They should use animations and visuals. Just slides are boring...	Use of multimedia tools in content		

Table 2 Demographic variables of participants

Qualitative Variables	Grouping	Professors N (%)	Students N (%)
Gender	Female	6 (54.54%)	29 (53.7%)
	Male	5 (45.45%)	25 (46.3%)
Field of Study	Nursing	2 (18.18%)	10 (18.52%)
	Emergency Medicine	1 (9.09%)	7 (12.96%)
	Operating Room	1 (9.09%)	5 (9.26%)
	Anesthesia	1 (9.09%)	5 (9.26%)
	Health Information Technology	1 (9.09%)	5 (9.26%)
	Environmental Health	2 (18.18%)	6 (11.11%)
	Occupational Health	1 (9.09%)	6 (11.11%)
	Public Health	1 (9.09%)	4 (7.4%)
	Midwifery	1 (9.09%)	6 (11.11%)
	Mean ± SD		
Quantitative Variables			
Age		43.2 ± 5.4	21.45 ± 4.35
Years of teaching experience (for instructors)/ GPA (for students)		9.92 ± 5.3	16.89 ± 1.64

Table 3 Classification of strategies for enhancing the quality of virtual education from the perspective of participants

Subcategories	Categories
Regular and Scheduled Teaching	Instructor-related Strategies
Engaging Content Design	
Aligning Virtual Education with In-Person Learning	
Effective Virtual Assessment	
Designing Standard Assignments	
Activating Students in Learning	
Constructive Interaction with Students	Managerial and Organizational Strategies
Monitoring Faculty Teaching Quality	
Empowering Faculty	
Supporting Low-Income Students	
Improving Infrastructure	

During the content analysis process, numerous initial codes were generated, which were then summarized and consolidated into 154 primary codes. These primary codes were further categorized into 11 subcategories and two main categories: instructor-related strategies and managerial/organizational strategies. The main categories and subcategories are presented in Table 3 and Diagram 1. A detailed description of each category follows.

1. Instructor-related strategies

Participants suggested several instructor-focused strategies to enhance the quality of virtual education. These strategies were organized into seven subcategories: “regular and scheduled teaching,” “engaging content design,” “aligning virtual education with in-person learning,” “effective virtual assessment,” “designing standard assignments,” “activating students in learning,” and “constructive interaction with students.” Each subcategory is described in detail below.

1-a) regular and scheduled teaching

Students emphasized the importance of instructors being organized in uploading educational content and

conducting online classes. They suggested that instructors should provide a course plan prior to the start of the sessions and ensure that classes and content uploads occur regularly and according to a predetermined schedule, with timely notifications to students. As one participant stated, “Instructors should regularly upload a manageable amount of material on specific dates, instead of waiting a long time and then posting everything at once. This helps students plan better.”

1-b) engaging content design

Participants highlighted the need for high-quality educational content. One participant noted, “Educational content should be simple, engaging, understandable, and at the same time comprehensive and practical to motivate students. Appropriate fonts, images, and animations should be used to avoid tiring students. The teaching content should focus on the main points and avoid unnecessary details. Instructional videos should be short (about 10–15 minutes) to prevent student fatigue.”

1-c) aligning virtual education with In-Person learning

Participants stressed that instructors should maintain high standards and quality in virtual teaching, striving to make it as close to face-to-face education as possible. They recommended using diverse and creative teaching methods, leveraging all available capabilities of the virtual education system to enhance student learning, and holding occasional online or in-person sessions to address questions and summarize content. One participant mentioned, “In virtual education, we should focus more on the quality rather than just the amount of education. Having question and answer sessions in online classes is really useful and can help replicate the feel of in-person classes.”

1-d) effective virtual assessment

Improving the quality of student evaluations was another key strategy identified. Participants suggested several improvements, including appropriate exam duration, time limits for entering and exiting exams, diverse assessment methods (assignments, attendance, class participation), providing answer keys post-exam, ensuring the number of questions aligns with the course content, and implementing identity verification methods such as visual confirmation. They also emphasized designing exam questions that assess higher-order thinking skills. One participant stated, “For exams, the duration should be balanced—not too long to avoid cheating, and not too short to prevent stress. Instructors should design exam questions that go beyond basic knowledge and include analysis, synthesis, and application, as these are harder to cheat on and require a deeper understanding of the material.”

1-e) designing standard assignments

Participants believed standardized assignments are crucial for enhancing student learning and virtual education quality. Assignments should be motivating, interesting, and assess higher-order thinking skills. Their number, volume, and difficulty should be appropriate. Timely feedback and clear communication of deadlines and expectations were also emphasized. Assignments should be uploaded in designated sections, not within general course files. One participant said, “The assignments assigned by instructors should be creative, challenging for students, and motivating. They shouldn’t simply be copied from the textbook.” Another student highlighted, “Instructors should provide feedback on our assignments. Some instructors either don’t provide feedback at all or provide it very late. When we submit our assignments, we should be told whether our answers are correct or not. Otherwise, we might think our assignments aren’t even being checked. So, what’s the point of giving assignments?”

1-f) activating students in learning

Participants emphasized the role of instructors in motivating and engaging students for more effective learning. They suggested that instructors challenge students during online classes by asking questions and focusing their attention on the lesson. Asking questions not only engages students but also helps instructors ensure comprehension and allows for clarification when needed. One participant said, “During online classes, instructors should engage students by asking questions to ensure they understand the material and are paying attention. Some instructors overlook this and rush through the material instead.”

1-g) constructive interaction with students

Participants believed that enhancing instructor-student interaction significantly improves virtual education quality. They recommended prompt responses to student questions, considering student feedback to improve teaching quality, and ensuring both instructors’ and students’ faces are visible during virtual classes to facilitate better engagement. Introducing discussion topics on online platforms and organizing group conferences and collaborative assignments were also suggested to promote peer interaction. One participant stated, “Interaction between instructors and students improves the quality of virtual education. For example, two-way audio and video communication can keep students engaged and make them feel more present in the class, while also making the material easier to understand.”

2. Managerial/Organizational strategies

This category encompassed four subcategories: monitoring faculty teaching quality, empowering faculty, supporting low-income students, and improving infrastructure. Each is described below:

2-a) monitoring faculty teaching quality

Participants emphasized the need for clear quality indicators for virtual education and regular oversight of faculty performance. They suggested that if teaching quality is inadequate or students express dissatisfaction, constructive feedback should be provided to the faculty member. One student stated, “Department heads should monitor faculty throughout the semester by gathering student feedback and evaluating performance. End-of-semester evaluations alone aren’t enough. Continuous monitoring can help identify and address issues early, preventing students from struggling due to unprepared faculty.”

2-b) empowering faculty

Given that virtual education was uncommon in medical education prior to the COVID-19 pandemic, faculty members were often unprepared for this transition.

Participants highlighted the need for training faculty on effective use of virtual education systems. They recommended conducting workshops to help faculty create high-quality educational content and become proficient with educational software. One participant noted, “Faculty should be skilled in using various software to create engaging content like videos and animations. Universities should organize workshops to help faculty develop these skills.”

2-c) supporting Low-Income students

Some participants pointed out that purchasing necessary equipment for virtual education, such as laptops, smartphones, and internet access, could pose challenges for low-income students. To prevent disruptions in their education, participants suggested that governments and universities provide loans or free internet packages to support these students. As one participant stated, “For students facing economic difficulties, the government or universities should offer free internet plans or assistance, so they don’t fall behind in their studies.”

2-d) improving infrastructure

Participants identified the improvement of online education infrastructure as a key factor in enhancing virtual education quality. They suggested providing flexible and feature-rich software platforms, regularly upgrading the virtual education system, collecting feedback from faculty and students to identify and resolve system issues, and ensuring access to advanced technologies such as artificial intelligence and virtual reality. Additionally, participants recommended preparing acoustically suitable spaces for faculty to record lectures and learning from the experiences of successful national and international universities. One participant stated, “We need a flexible software platform for virtual education. Those in charge should listen to feedback from both students and faculty to resolve any issues and improve the quality of virtual education.”

Discussion

This qualitative study aimed to explore and identify strategies to improve the quality of virtual education from the perspective of medical sciences faculty and students. Through content analysis of individual and focus group interviews, several key themes and subcategories emerged, highlighting the importance of both instructor-related and organizational strategies. The findings provide valuable insights into specific areas that require attention to enhance the virtual learning experience for medical sciences students.

The study revealed several strategies related to instructors that are crucial for enhancing the quality of virtual education. Based on the results, instructors can improve

virtual education by conducting regular and scheduled teaching, designing engaging educational content, aligning virtual education with in-person learning through innovative and creative teaching methods, improving the quality of student assessments, assigning motivational and meaningful assignments, actively engaging students in the learning process, and increasing constructive interaction with students.

Consistent with these findings, Keshavarzi and colleagues reported that enhancing teaching quality through the use of practical and clear examples, employing creative teaching methods, ensuring regular and organized teaching, engaging students in classes by posing essential and effective questions, assigning homework, incorporating students’ feedback throughout the semester, diversifying evaluation methods, and creating an interactive environment are among the key instructor-related strategies for improving the quality of virtual education [26]. Similarly, in the study by Yazdani and colleagues, the most desirable characteristics of faculty members in e-learning from the students’ perspective included managing and motivating students, fostering virtual interaction, providing adequate support, demonstrating electronic commitment, ensuring an interactive environment, and maintaining a positive attitude toward e-learning [27]. The instructor’s role encompasses designing and developing the learning experience, guiding and supporting learners, and evaluating learning outcomes. Furthermore, instructors should understand students’ abilities and provide timely, constructive feedback [28].

While several previous studies have emphasized technological barriers and faculty preparedness as core challenges in virtual education [5, 6, 10], our findings suggest a shift in learners’ expectations, particularly toward structured teaching practices, timely feedback, and active student engagement. These elements, although mentioned in past research, were not explored in-depth as key quality indicators. This highlights the evolving nature of virtual education, where organizational structures and pedagogical strategies are becoming as critical as technological access.

Participants stressed the importance of consistency and adherence to a structured teaching schedule. Regular and predictable sessions help maintain continuity and enable students to plan their study schedules effectively. This finding aligns with existing literature that underscores the significance of structured course delivery in online education for fostering student engagement and academic success [29, 30].

Participants also highlighted the need for educational content that is both relevant and engaging. According to their perspectives, virtual educational content should be of high quality, sufficiently detailed yet understandable, and accessible to students at any time. The value

of engaging content design, particularly the use of multimedia elements and concise instructional videos, is supported by Cognitive Load Theory. This theory posits that reducing extraneous information allows learners to focus on essential concepts, thereby enhancing comprehension and learning outcomes. Recent applications of Cognitive Load Theory in online medical education have demonstrated that simplified, visually supported content improves understanding and reduces learner fatigue [31, 32]. In line with these findings, other studies have identified poor-quality uploaded content as a factor that diminishes the effectiveness of electronic education courses [33, 34].

Participants emphasized that instructors and their teaching methods play a crucial role in enhancing the quality of virtual education. They noted that instructors should strive to make virtual learning environments as similar as possible to in-person experiences. Key strategies include maintaining high teaching standards, employing diverse and engaging instructional methods, and incorporating creativity and innovation into their teaching practices. Effective online teaching requires more than simply delivering content; it involves actively engaging students in the learning process [26].

Moreover, participants pointed out that evaluation methods significantly impact the perceived quality of virtual education. This observation is consistent with findings from other studies, which highlight the central role of assessment quality in virtual learning environments [35]. Fair and comprehensive evaluation methods are essential for accurately assessing students' understanding and competencies. Participants recommended diversifying assessment strategies to include practical assessments, projects, and interactive assignments alongside traditional exams. This recommendation aligns with Gikandi et al., who emphasize the importance of diverse and comprehensive assessment methods in accurately evaluating students' knowledge and skills in online education settings [36].

Participants emphasized that creating standardized assignments is essential for student learning and improving the quality of virtual education. This perspective is consistent with the findings of Chamasemani et al., who reported that the use of well-designed, course-related assignments throughout the semester positively influences the quality of virtual education [37]. Standardized assignments ensure equal opportunities for all students to succeed by establishing clear expectations and performance criteria, which contribute to a fair and supportive learning environment [38].

The importance of structured and clearly defined assignments can also be interpreted through the lens of Self-Determination Theory (SDT), which posits that intrinsic motivation thrives when learners experience

autonomy, competence, and relatedness [39]. By providing meaningful tasks, timely feedback, and opportunities for independent work, virtual education can fulfill these psychological needs and enhance students' motivation and engagement. Supporting this view, research in virtual education settings has demonstrated that when students receive clear guidance and meaningful assignments, their intrinsic motivation and overall academic satisfaction significantly increase [40].

Furthermore, participants identified constructive interaction and effective communication between instructors and students, as well as actively engaging students in the learning process, as key factors in improving the quality of virtual education. Positive and interactive relationships between instructors and students create a more engaging and supportive learning environment, ultimately enhancing the virtual learning experience. This finding aligns with numerous studies that have underscored the critical role of instructor-student interaction in online education [37, 41–44].

Elements such as establishing visual communication with students, engaging them during the learning process, providing real-time feedback [37], fostering a supportive environment [43], and promptly responding to students' questions [42] have been identified as significant contributors to the quality of virtual education. These align with the results of the current study. Moreover, the emphasis on activating students in learning and promoting constructive interaction reflects the principles of Constructivist Learning Theory, which posits that knowledge is constructed through active engagement, reflection, and social interaction [45]. Encouraging participation and establishing feedback mechanisms in virtual education supports deeper learning and collaborative knowledge construction, ultimately improving educational outcomes [46].

The study also underscored the significance of managerial and organizational aspects in enhancing the quality of virtual education. From the participants' perspectives, managerial and organizational strategies were considered as important as instructor-related strategies in ensuring effective virtual education. Participants highlighted that educational center management teams could play a crucial role in improving the quality of virtual education through measures such as monitoring the quality of teaching, empowering instructors to enhance their virtual teaching competencies, supporting low-income students, and improving technological infrastructure.

Consistent with these findings, Hedavand and Kashan-chi reported that monitoring teaching quality and ensuring instructor competence in e-learning courses are key determinants of success in virtual education environments [47]. Regular monitoring and evaluation of instructors' teaching practices are essential to

maintaining high educational standards. Establishing feedback mechanisms enables instructors to reflect on their performance, identify areas for improvement, and adapt their teaching methods accordingly [48]. Moreover, faculties and instructors are encouraged to design their courses in alignment with established virtual education standards, such as online education quality frameworks [49]. Studies have demonstrated that adherence to such standards not only improves learning outcomes but also increases student engagement and satisfaction in virtual settings [49, 50].

Participants also emphasized the importance of empowering instructors by providing necessary resources and training opportunities to enhance their virtual teaching skills. Training programs and workshops can build instructors' confidence and equip them with the skills needed to design and deliver engaging and effective virtual education [48]. Supporting these findings, Chemasani et al. highlighted that empowering faculty to effectively utilize virtual education tools is a significant factor in improving the quality of online education [37]. Similarly, Moslehi and Alidoust identified faculty proficiency in teaching electronic courses as one of the most critical instructor characteristics influencing the quality of virtual education [42]. These observations highlight the need for institutions to invest in faculty development programs to support the transition to and continuous improvement of virtual learning environments.

Providing learners with technological tools and offering free internet access to both learners and teachers were identified as essential strategies for improving the quality of virtual education, as highlighted in the study by Hajizadeh et al. [51]. Financial support measures, including the provision of essential hardware and software and subsidies for internet access, are critical to ensuring that economic barriers do not impede students' educational opportunities. Addressing financial constraints helps ensure equitable access to online learning, enabling all students to benefit from virtual education opportunities regardless of their socioeconomic status.

Improvement of technological infrastructure was also identified as a key factor in promoting effective virtual education in the present study. In line with these findings, multiple studies have emphasized that developing infrastructure and providing support for virtual education users significantly impact the quality of virtual learning environments [52–54]. Similarly, Yazdani et al. identified technology, learner support, and technical assistance as foundational components of effective e-learning systems [27]. A review of the literature reveals that many challenges associated with virtual education infrastructure stem from issues related to e-learning tools, including the lack of robust technological platforms, software glitches, and hardware limitations [26, 54–57].

Without establishing the necessary infrastructure, the implementation and effectiveness of virtual education cannot be realistically achieved. The sudden and imposed initiation of virtual education in Iran during the COVID-19 pandemic occurred without adequate preparation, resulting in significant “virtual education infrastructure challenges” for both instructors and students [58]. Since the virtual environment relies heavily on stable internet connectivity, disruptions in internet service can severely affect virtual education processes. For instance, bandwidth limitations or low data transfer speeds during simulations and video conferences can hinder the quality of instruction and student engagement [59]. Nonetheless, with sufficient financial investment and the provision of appropriate infrastructure—such as high-speed internet connections and affordable, reliable hardware and software—a conducive environment can be created that supports the advancement of the country's educational and scientific development [60].

Notably, many earlier studies have framed the challenges of virtual education primarily in terms of infrastructure and access issues [10, 55, 56]. In contrast, our participants highlighted psychological aspects such as motivation, emotional engagement, and the need for ongoing instructor presence. These findings suggest a broader and more nuanced definition of quality in virtual education—one that encompasses relational and emotional dimensions in addition to technical readiness.

To further enrich the interpretation of these findings, this study draws on key theoretical frameworks in distance education and instructional design. Moore's Theory of Transactional Distance [61] underscores the importance of structure, dialogue, and learner autonomy in virtual education. The participants' emphasis on consistent scheduling, active instructor-student interaction, and timely feedback aligns closely with this model, which posits that increased structure and effective communication reduce psychological distance and enhance learning outcomes in online environments.

Additionally, the Technology Acceptance Model (TAM) developed by Davis [62] provides a valuable lens for understanding faculty engagement in virtual teaching. The study's findings—particularly the need to empower instructors through training and to offer user-friendly digital platforms—echo TAM's core constructs of perceived usefulness and perceived ease of use, both of which are critical determinants of educators' willingness to adopt and effectively utilize educational technologies.

Furthermore, the principles of the ADDIE instructional design model (Analysis, Design, Development, Implementation, and Evaluation) support a systematic approach to enhancing virtual learning. Several participant suggestions—such as the creation of needs-based content, iterative feedback mechanisms, and the

incorporation of multimedia elements—are directly aligned with the stages of the ADDIE framework, highlighting the importance of comprehensive instructional design processes in virtual education [63]. These theoretical models not only reinforce the empirical themes identified in this study but also provide a structured foundation for understanding how and why specific strategies can effectively improve the quality of virtual education.

By integrating both instructor-related and managerial/organizational strategies, this study offers a comprehensive framework that extends beyond what has been previously documented. The emphasis on standardized assignments, continuous quality monitoring, and support for low-income students introduces practical dimensions that are often underrepresented in earlier models [26, 37, 47]. These insights contribute to a more holistic understanding of virtual medical education and may inform the development of future quality assurance frameworks, particularly in resource-constrained educational settings.

This study contributes several important innovations to the literature on virtual education in medical sciences and offers practical implications for educational policy-making. First, by incorporating the perspectives of both students and faculty, it provides a comprehensive view of the challenges and needs in virtual learning environments. Second, it categorizes improvement strategies into two main domains: instructor-related and managerial/organizational, offering both theoretical clarity and practical guidance for stakeholders at various levels—from individual educators to institutional leaders and policymakers. Third, it underscores the importance of aligning virtual education with the unique demands of medical training, including the development of clinical and practical skills, and highlights the need to support low-income students to ensure equity in access to education. Fourth, the proposed strategies—such as designing engaging content, facilitating active learning, fostering constructive faculty-student interactions, and implementing effective virtual assessments—are aimed at enhancing the quality and effectiveness of online teaching. Finally, the findings emphasize the critical role of organizational support, infrastructure development, and faculty empowerment in ensuring the success of virtual education, thereby presenting a practical roadmap for institutional advancement and policy development.

Implications for practice and policy

The findings of this study have important implications for both educational practice and policy-making. Educational institutions should prioritize the continuous professional development of faculty members to improve teaching quality in virtual learning environments. Policies should be established to ensure systematic monitoring of teaching practices, accompanied by timely and

constructive feedback mechanisms. Additionally, providing targeted support for low-income students and investing in robust technological infrastructure are critical steps toward fostering an inclusive and effective virtual learning environment.

It is also essential to consider the context-specific nature of these findings, as the study was conducted within a single Iranian medical university. Factors such as institutional culture, national educational policies, and variations in technological infrastructure can significantly affect the implementation and effectiveness of virtual education strategies. For example, challenges related to internet connectivity and faculty readiness reported by participants may be more acute in under-resourced institutions or low-income countries. Conversely, strategies like enhancing faculty training, designing engaging content, and supporting economically disadvantaged students are likely to have broad relevance across different contexts. Therefore, while the insights from this study offer valuable guidance for improving virtual medical education, their generalizability should be carefully assessed in relation to specific institutional and national circumstances.

Limitations and future research

While this study provides valuable insights into strategies for enhancing the quality of virtual education, several limitations should be acknowledged. First, the research was conducted within a single medical sciences university, which may restrict the generalizability of the findings to other academic disciplines, institutions, or cultural contexts. Second, the voluntary nature of participation may have introduced self-selection bias, as individuals with particularly positive or negative experiences or strong opinions about virtual education may have been more inclined to participate. Third, social desirability bias may have affected participants' responses, especially in focus group discussions, where students in particular might have shared opinions they believed to be socially acceptable or aligned with the expectations of others.

Future research should explore similar strategies in diverse educational and cultural settings to assess the broader applicability of these findings. Additionally, longitudinal studies could provide valuable insights into the long-term effectiveness and sustainability of the proposed strategies for enhancing virtual education quality.

Conclusion

This study highlights the multifaceted approach required to improve the quality of virtual education from the perspectives of both medical sciences faculty and students. By addressing both instructor-related and managerial/organizational strategies, educational institutions can foster more effective, engaging, and inclusive virtual

learning environments. The insights gained from this research can inform policy and practice, guiding institutions in developing targeted interventions to enhance the quality of virtual education and ultimately support better learning outcomes for students and professional satisfaction for educators.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12909-025-07713-7>.

Supplementary Material 1

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Author contributions

MS conceptualized and designed the study; MS and MP collected the data; MS and MP analyzed the data, MS wrote the manuscript. All authors read and approved the final manuscript.

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Data availability

All data are presented in the manuscript.

Declarations

Ethics approval and consent to participate

This study received ethical approval from Saveh University of Medical Sciences under the code IR.SAVEHUMS.REC.1399.021. The researchers adhered to the principles of the Helsinki Declaration and international ethical guidelines for research throughout all stages of the study. Participation was voluntary, and all participants provided written informed consent for both participation and audio recording. Interview transcripts were prepared verbatim based on participants' statements, which were reported anonymously to ensure confidentiality.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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