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Original article

Evaluation of Medical Students' Experience with Technology-Based Learning at the University of Benghazi

Munira Khalifa*, Asma Salem[2], Nadia Eldarogi[3]

Department of Family and Community Medicine, Faculty of Medicine, University of Benghazi, Libya
Corresponding email. *Munira.khalifa@uob.edu.ly*

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Technology-Based Learning, Satisfaction, Medical Students, University of Benghazi.

ABSTRACT

Technology-based learning (TBL) became of great importance in medical education, especially with the occurrence of the COVID-19 pandemic globally, highlighting its potential while revealing implementation barriers in resource-limited settings. This study examined medical students' experiences and perceptions of TBL and its key barriers to identify obstacles to its implementation at the University of Benghazi. A cross-sectional study was conducted in December 2023 among medical students across all academic levels. Data were gathered using a self-administered questionnaire. Participants were selected using a probability proportional to size sampling. Analysis was performed using descriptive and inferential statistics in SPSS . The study surveyed 586 medical students (mean age 25.3 ± 2.55 years). The sample showed predominance of females (72.5%), with most reporting at least intermediate computer skills and representation from all academic stages, including the internship phase. Overall, digital access was high, with 96.1% reporting continuous internet access and 77.8% using it daily for educational updates, although only about one-third (35.2%) perceived institutional technical support as adequate for TBL. Student satisfaction with TBL was generally favorable, as 64.3% reported high or very high satisfaction, and 61.3% believed that TBL can successfully substitute traditional education, while 92.3% preferred a blended model integrating both approaches. A majority perceived TBL as effective in achieving learning objectives (60.6%), and an even higher proportion regarded it as fundamental for education (83.1%). Nevertheless, many participants reported limitations related to interactivity, motivation, group discussion, and communication with faculty, and highlighted institutional infrastructure and staff technical skills as more prominent barriers than student-related factors. The study shows that TBL is an essential component of modern medical education. Students' technology skills and access to free online resources were key factors influencing satisfaction and willingness for learning engagement. The majority of participants reported that combining traditional with TBL is the most effective strategy to enhance the educational outcomes while reducing limitations in face-to-face communication skills associated with digital learning methods.

Introduction

Medical education has progressively shifted from traditional printed formats to digital methods of knowledge transfer. This transition has become an imperative necessity, particularly following the COVID-19 pandemic [1,2]. While traditional lectures and textbooks still have value, they often fail to engage modern learners who are used to digital learning, especially in the era of artificial intelligence [3,4]. New teaching methods, such as problem-based learning, integrated basic and clinical sciences, flipped classrooms, and technology-based education tools, have emerged. These methods are maximized by integrating technology, enhancing both efficiency and engagement [5–9].

Technology-based learning (TBL) is an educational approach that uses modern technological tools, online platforms, and multimedia resources to enhance students' learning experiences and to facilitate collaboration and interaction between learners and instructors, whether on campus or at a distance, as happened when the COVID-19 pandemic forced the stop face to face education [3,6,8,10].

Although traditional face-to-face teaching in medical schools offers important advantages, including real-time interaction, direct supervision, and awareness of social and community contexts [6,7,11] An overreliance on didactic lectures may promote passive learning and limit opportunities for individualized feedback, case-based discussion, and repeated practice. Furthermore, circumstances such as complete institutional closures highlight the necessity for alternative educational strategies to ensure continuity of medical training [3,6,9-12].

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Despite its advantages, TBL faces several challenges, including the digital divide limiting access to reliable devices and internet connectivity, especially in low-resource settings [7]. Additional barriers include faculty resistance or limited training in educational technology, concerns about reduced spontaneous interaction and hands-on experiences, and the need to ensure alignment between digital activities and curricular learning outcomes [13]. Furthermore, Artificial intelligence (AI) represents a rapidly emerging component of TBL, offering opportunities for adaptive learning systems, automated feedback, and data-driven curriculum analytics, but also raising issues related to data privacy, assessment integrity, and regulatory oversight [14]. Overall, the literature supports viewing TBL as a core, evolving element of modern medical education, with ongoing evaluation of students' perceptions and outcomes essential to optimize implementation and to guide institutions in refining blended, simulation-based, and AI-enhanced curricula for future healthcare professionals.

Consistent with international accreditation standards, the Faculty of Medicine at the University of Benghazi has established a Clinical Skills and Simulation Center incorporating advanced technologies such as virtual reality to support simulation-based learning. This initiative aims to enhance clinical competence, reasoning, and patient safety through structured, repeatable practice. Nevertheless, effective implementation requires sustained investment in faculty development, technical support, and curricular integration to address challenges commonly encountered during early adoption. TBL represents a promising and innovative instructional approach for medical schools and university students. Ongoing collection and reflection on students' feedback are essential for improving any possible educational outcomes and overcoming emerging challenges during the implementation of new educational strategies. This study aimed to explore students' experience of the integration of technology in medical education within the faculty of medicine at the University of Benghazi.

Methods

Study design and setting

A cross-sectional study design was conducted at the Faculty of Medicine, University of Benghazi, Libya.

Target population

All medical students in the medical faculty across different academic years were eligible to participate. They include: Medical students at pre-clinical (first -second-third years), clinical (fourth – fifth years), and internship (recent graduates completing their internship) stages.

Sampling technique and sample size

Probability proportional to size (PPS) sampling was used to ensure proportional representation, whereby larger sub-groups (e.g., pre-clinical students) contributed more to the sample than smaller groups (e.g., interns). Students were first stratified by academic stage. The total number of students in each stratum was obtained through an official request from the Department of Family and Community Medicine to the Dean, who addressed the Registrar's Office to provide enrolment lists by academic year. The sample size within each stratum was then allocated proportionally to its size in the source population. All students who were present at the time of data collection and met the eligibility criteria were invited to participate until the targeted number for each stratum was reached. The sample size for each stratum was proportional to its size in the total population.

Time and duration of the study and data collection

Data collection took place in December 2023 and extended over a period of one month and five days. A semi-structured, self-administered questionnaire, adapted from published tools on e-learning and technology-enhanced medical education, was developed and piloted among intern students and medical educators before expert review in community medicine for content validity and clarity.

Research tool

The constructed questionnaire comprised four sections as follows: (1) sociodemographic and academic characteristics (e.g., age, sex, academic year, self-rated computer skills, prior blended learning experience); (2) technology access and institutional support via three Yes/No items on daily internet access/use and technical adequacy; (3) satisfaction with technology -based learning using a 4-level scale and dichotomous views on substituting/combining TBL with traditional teaching; and finally (4) perceived effectiveness, engagement, necessity, and barriers assessed via 5-point Likert items (strongly disagree to strongly agree, collapsed to disagree/neutral/agree for analysis by figures).

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For ethical consideration, responses were anonymous, with implied consent via voluntary completion after informing study aims and withdrawal rights; data were collected securely without identifiers to ensure confidentiality.

Results

The final sample comprised 586 medical students, all from the Faculty of Medicine, with a mean age of 25.3 ± 2.55 years (range from 20-31 years). The majority of participants were female, with 425 students (72.5%) compared with 161 males (27.5%). With respect to computer skills, most students reported intermediate proficiency (387; 66%), while smaller proportions described their skills as basic (29; 4.9%) or advanced (170; 29%). Across academic grades, students were represented from all stages of the medical program: first year (64; 10.9%), second year (91; 15.5%), third year (104; 17.7%), constituting together the preclinical stage, fourth year (119; 20.3%), and fifth year (85; 14.5%), constituting together the clinical stage, and finally internship students (123; 21%). A total of 36.3% of the students identified that they had experienced education in a blended environment (combined traditional teaching and TBL) before, 63.3% affirmed that they had not (Table 1).

Table 1. Distribution of Demographic Characteristics of Students.

Variable	Mean + SD	N(%)
Age (y)	25.3 ± 2.55.	
Gender	Male	161(27.5)
	Female	425(72.5)
Computer skills	Basic	29(4.9)
	Intermediate	387(66)
	Advanced	170(29)
Academic stage	Preclinical	259 (44.2)
	Clinical	204(34.8)
	Internship	123(21)
Blended learning experience	Yes	215(36.7)
	No	371(63.3)

Assessment of technology availability, usability, and institutional support adequacy

The digital readiness of the students and their perceptions of institutional infrastructure were assessed through their reliable internet access and perceived institutional support that form foundational enablers for TBL adoption. The results showed that most respondents (563; 96.1%) reported having daily Internet access, while only 23 (3.9%) did not. Furthermore, more than two-thirds of the students (456; 77.8%) accessed the Internet daily to check updates and announcements regarding their education. However, only about one-third (206; 35.2%) believed that institutional technical support was adequate for adopting TBL (Table 2).

Table 2. Responses on Technology Infrastructure Perceptions

Statement	Response	
	Yes N (%)	No N (%)
Daily Internet access confirmed	563(96.1)	23(3.9)
Daily Internet use for updates/announcements	456(77.8)	130(22.2)
Adequate technical support for TBL	206(35.2)	380(64.8)

Overall satisfaction with Technology-Based Learning

Among all participants, overall satisfaction with TBL was categorized into low, medium, high, and very high levels. Low satisfaction was the least common and was reported by 72 students (12.3%). Medium satisfaction was evident among 137 students (23.4 %), while the largest proportion of students (238; 40.6%) had a high level of satisfaction. Finally, very high satisfaction was reported in 139 participants (23.7 %) (Table 3).

Table 3. Distribution of students' overall satisfaction with technology-based learning. (n=586)

Satisfaction level	Frequency (%)
Low	72 (12.3)
Medium	137 (23.4)
High	238 (40.6)
Very high	139 (23.7)

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Students' perceptions of substituting or combining traditional education with TBL

Among 586 respondents, 359 students (61.3%) believed that TBL could successfully substitute traditional educational methods, while 227 (38.7%) disagreed. Many of the students (541; 92.3%) favored blending (combining) technology-based and traditional learning methods, with only 7.7% (n=45) disagreeing. Students 'perceptions of e- lectures' usefulness relative to traditional presentations revealed a near-even divide among exposed participants, where 253 (43.2%) rated e-lectures superior to traditional lectures, and 246 (42%) found no advantage, while 87 (14.8%) lacked experience with e-lectures (Table 4).

Table 4. Students' perceptions of Technology-Based Learning substitution versus combination with traditional methods and e-course advantages

Student perception	Response	N (%)
TBL can substitute traditional education	Yes	359(61.3)
	No	227(38.7)
Combining TBL and traditional learning is a better approach	Yes	541(92.3)
	No	45(7.7)
e-lectures are more useful than traditional lectures	Not experienced	87(14.8)
	Yes	253(43.2)
	No	246(42)

Perceived Effectiveness and Necessity of TBL

Most students believed that TBL methods met expected learning objectives (355;60.6%), a significant minority disagreed (231; 39.4%). Additionally, most of the participants viewed TBL as fundamental in modern medical education (487;83.1%), whereas only 16.9% of the study sample disagreed (Figure 1).

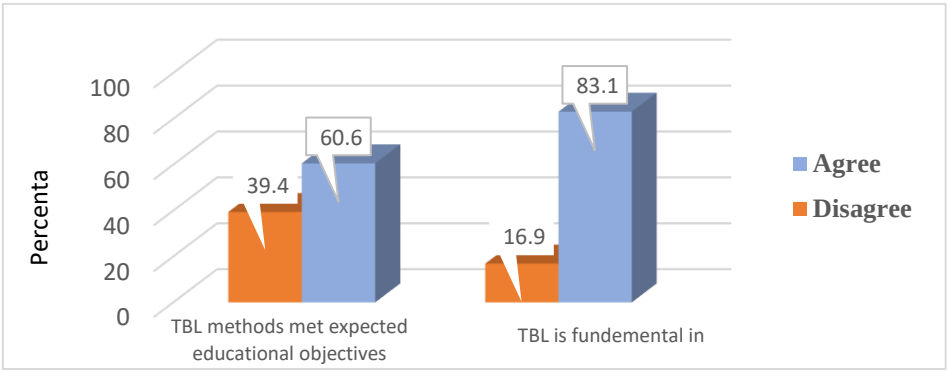

Figure 1. Students' perceived effectiveness and necessity of Technology-Based Learning in medical education.

Perception of online education among medical students

Participants demonstrated mixed perceptions of TBL, with varying levels of agreement regarding its benefits and areas for improvement. Firstly, an overwhelming majority, 499 (85.2%), agreed that "online lectures need to be more interactive," with 78 (13.3%) neutral and only 9 (1.5%) disagreeing. Secondly, during the pandemic, motivation appeared to be reduced, as 468 students (79.9%) disagreed that online learning helped them develop motivation to complete their studies, 90(15.4%) were neutral, and only 28(4.8%) agreed. Thirdly, regarding whether TBL facilitated group discussions, 310 (52.9%) disagreed, 221 (37.7%) were neutral, and only 55 (9.4%) agreed. Fourthly, concerning TBL's role in strengthening communication with lecturers and colleagues, 340 participants (58%) disagreed, 133 (22.7%) remained neutral, and 113 (19.3%) agreed. The fifth item examined the perception of students toward the effect of TBL on improving students 'study skills; responses were more balanced: 228 (38.9%) disagreed, 207 (35.3%) were neutral, and 151 (25.8%) greed (Figure 2).

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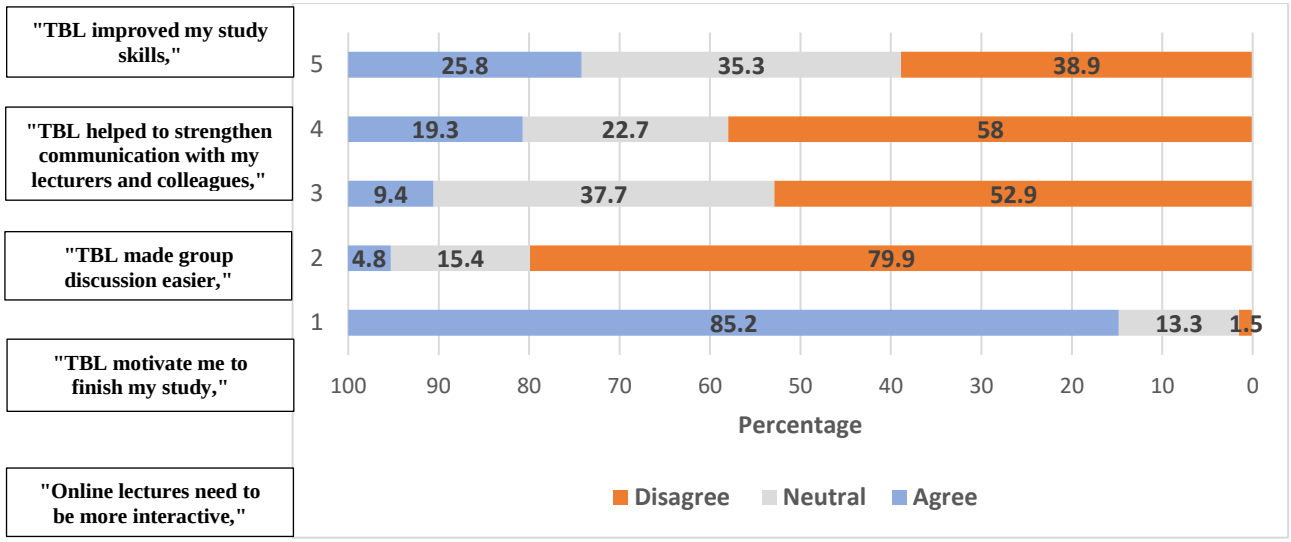

Figure 2. Perception of online education among medical students in the Faculty of Medicine, University of Benghazi, during the COVID-19 pandemic

Students' perceptions of barriers to Technology-Based Learning

Participants identified three key barrier categories to TBL: student capabilities, institutional infrastructure/resources, and faculty teaching staff skills related to technology. Responses revealed almost balanced perceptions of student-related barriers, with 253 (43.2%) disagreeing that they contribute significantly, 87 (14.8%) neutral, and 246 (42%) agreeing. In contrast, predominant concerns emerged for institutional readiness, as the majority (283; 48.3%) disagreed that the medical faculty possesses adequate infrastructure and resources for online teaching, followed by 212 (36.2%) in agreement and 91 (15.5%) neutral. Similarly, 264 participants (45.1%) disagreed that faculty staff have the required online teaching technical skills, with 208 (35.5%) agreeing and 114 (19.5%) were neutral (Figure 3).

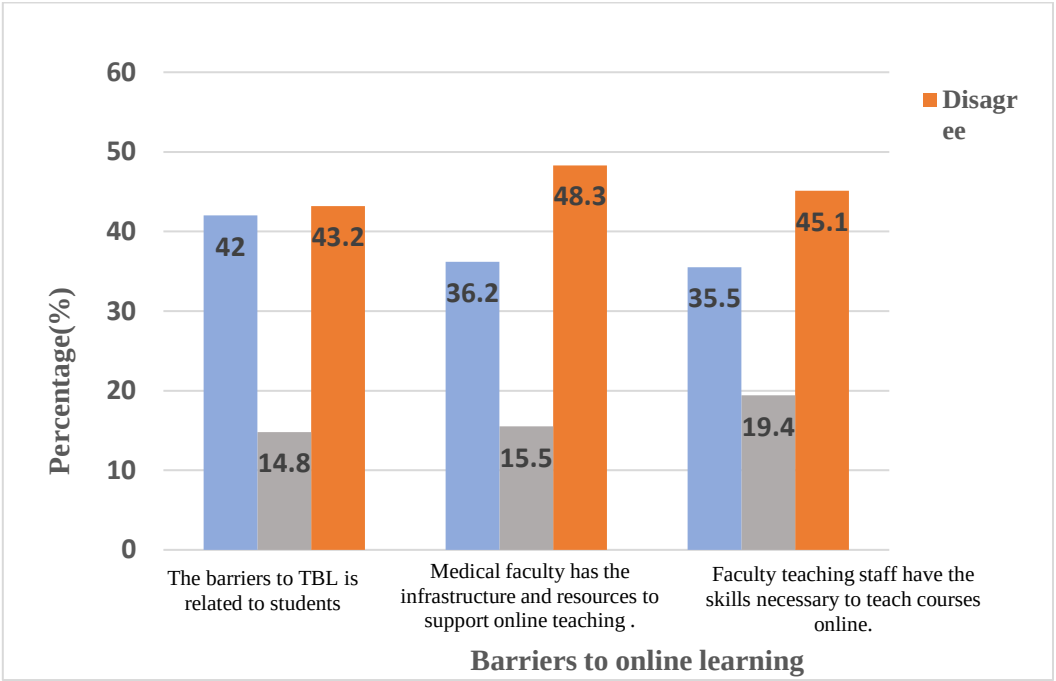

Figure 3. Students' perceptions of barriers and institutional readiness for technology-based learning

Discussion

The present study evaluated medical students' perceptions and experiences of technology-based learning at the University of Benghazi. In general, the findings show that students have a positive attitude toward the use of technology in medical education. Most participants reported being satisfied with technology-based

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learning, which reflects the increasing acceptance of digital learning as part of routine medical training rather than as a temporary solution used only during the COVID-19 pandemic [9,10].

One of the most critical findings of the current study was a strong preference of students for blended learning Although about 60.6%. Of the students who believed that TBL alone could achieve learning objectives, a significantly higher proportion, 92.3% of participants, preferred a combination of online learning and traditional face-to-face teaching. This suggests that while students appreciate the flexibility and accessibility of digital learning, they still value direct contact with instructors and classmates. Similar findings have been reported in previous studies, which emphasize that e-learning works best when it supports, rather than replaces, conventional teaching methods [3,6].

Despite these advantages, important challenges were identified. Limited virtual communication with peers and instructors was perceived as a key barrier to effective online learning. Nearly 43.2% of students reported that e-lectures did not offer clear advantages over traditional lectures. In medical education, where learning often depends on interaction, feedback, and practical guidance, the lack of face-to-face communication may reduce student engagement and limit learning effectiveness. Similar concerns have been reported by Çakmakkaya et al. in Turkey, and by Chaitra Mc et al. in India [11,15]. Another challenge examined in the present study was internet connectivity. Notably, our findings differ from those reported by Çakmakkaya and his colleagues [11], who found that 55% of students encountered connectivity issues during online learning; our results showed that 85.2% of participants did not face such challenges. This contrast underscores the variability in internet access and its impact on the effectiveness of TBL across different educational environments.

The effectiveness of TBL is also influenced by the availability of resources and technical support. In our study, 96.1% of students reported having regular access to the internet, which reflects good personal readiness for online learning. However, institutional support appeared to be limited, as only 35.2% of students felt that technical assistance was sufficient. This gap between student access and institutional support has been reported in other studies conducted in low-resource settings [7]. Furthermore, while most students reported their computer skills as intermediate, the increasing use of advanced tools such as simulation and virtual reality highlights the need for additional training to ensure students can use these technologies effectively [16,17].

In this study, many students reported difficulties related to engagement. Some students described online learning as monotonous and expressed a preference for in-person communication. These findings are consistent with previous research that has identified reduced interaction and increased screen fatigue as a common challenge in online learning environments [13]. It suggests that greater emphasis should be placed on interactive teaching methods, such as case-based learning and simulation, to improve student engagement and learning outcomes [18].

Participants in the present study highlighted institutional infrastructure and faculty technical skills as more prominent barriers to TBL than student-related factors, with nearly half disagreeing that the faculty had adequate infrastructure or sufficient staff skills for online teaching. These findings are consistent with the work of Bayomy et al. in Egypt, who reported that limitations in institutional readiness and technical support were major obstacles to the effective implementation of computer-based medical education [7]. Similarly, Maatuk et al. found that inadequate infrastructure, limited training of instructors, and technical difficulties were among the most frequently cited challenges to e-learning during the COVID-19 pandemic [19]. Verma et al. also emphasized that insufficient faculty preparation and resource constraints can hinder the use of interactive teaching methods in medical education [13], which may explain why our students perceived faculty- and institution-related barriers as particularly significant. These findings highlight the importance of faculty development programs to ensure educators are well-equipped to deliver high-quality learning approaches. Furthermore, according to Maatuk (2022), the COVID-19 pandemic highlighted the urgent need for alternative teaching approaches [19]. Extensive literature has shown that faculties adopting interactive online strategies can significantly enhance students' satisfaction and learning outcomes. The findings of the present study align with this evidence, suggesting that the integration of such approaches may represent an effective strategy for improving teaching and learning experiences at the University of Benghazi and other Libyan Universities [7,13,19].

Conclusion

This study highlights that technology-based learning is a critical component of medical education. We identified different factors, such as using technology skills and free internet resources, that significantly influence student satisfaction and willingness to engage. Most participants found that combining traditional with technology-based learning is an optimal strategy to enhance the educational outcomes while preserving the essential interpersonal communication skills often limited in purely digital settings.

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Recommendations
Institutions should provide and support the access and availability of different technological tools to facilitate effective students' engagement. We recommend implementing specific policies, such as providing free internet access and integrating regular technical training into the medical curriculum. These measures are essential to ensure equitable participation and prepare students for a variety of learning environments.

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Conflict of interests
The authors declare that they have no conflicts of interest related to this research.

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