

Selecting Synchronous Learning Platforms in Infrastructure-Constrained Libyan Higher Education: A Comparative Analysis of Zoom, Google Meet, and Microsoft Teams Using the Task–Technology Fit (TTF) Framework

Fardous Mohamed Eljadi ^{1*}, Fayrouz Mohamed Aljadi ²

¹ Computer Science Department, Faculty of Science, Tripoli University, Libya

² College of Applied Administrative and Financial Sciences, Tripoli, Libya

*Email: f.eljadi@uot.edu.ly

اختيار منصات التعلم التزامني في التعليم العالي الليبي في ظل قيود البنية التحتية: دراسة مقارنة لمنصات Zoom و Google Meet و Microsoft Teams باستخدام إطار ملائمة المهمة والتكنولوجيا (TTF)

فردوس محمد الجدي ^{1*}، فيروز محمد الجدي ²

¹ قسم الحاسب الآلي، كلية العلوم، جامعة طرابلس، ليبيا

² كلية العلوم الإدارية والمالية التطبيقية – طرابلس، ليبيا.

Received: 21-06-2026	Accepted: 12-09-2026	Published: 28-09-2026
		
Copyright: © 2026 by the authors. This article is an open-access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).		

Abstract

The widespread adoption of synchronous virtual learning has transformed video-conferencing platforms into essential components of higher education. Nevertheless, selecting an appropriate platform remains a significant challenge for universities operating under infrastructure constraints, where decisions are frequently driven by software availability or financial considerations rather than by instructional requirements and technological suitability. This paper proposes a Task–Technology Fit (TTF)-based evaluation framework for selecting synchronous learning platforms in infrastructure-constrained higher-education environments. The framework is demonstrated through a comprehensive comparative analysis of Zoom, Google Meet, and Microsoft Teams, considering their communication architectures, bandwidth adaptation mechanisms, instructional affordances, learning management system integration, deployment requirements, and operational suitability under unstable network conditions. The analysis incorporates the infrastructural realities of Libyan universities, including irregular electricity supply, inconsistent mobile-network performance, limited institutional licensing, and widespread dependence on mobile Internet access. The findings indicate that Zoom provides the strongest support for interactive and collaborative learning, Google Meet offers superior accessibility and bandwidth efficiency for large-scale teaching, and Microsoft Teams delivers the most comprehensive institutional integration through the Microsoft 365 ecosystem.

A practical decision framework is proposed to assist universities in selecting virtual-learning platforms according to instructional objectives, available infrastructure, and institutional priorities.

Keywords: Virtual education, task–technology fit, video conferencing, higher education, infrastructure constraints.

المخلص

أدى الاعتماد الواسع النطاق لأسلوب التعليم الافتراضي التزامني إلى تحويل منصات المؤتمرات المرئية إلى مكونات أساسية في مؤسسات التعليم العالي. ومع ذلك، لا يزال اختيار المنصة المناسبة يشكل تحدياً كبيراً للجامعات التي تعمل في ظل قيود البنية التحتية، حيث غالباً ما تُتخذ القرارات بناءً على توفر البرمجيات أو الاعتبارات المالية بدلاً من المتطلبات التدريسية والملاءمة التكنولوجية. تقترح هذه الورقة إطار تقييم قائماً على نموذج "ملاءمة المهمة والتكنولوجيا (TTF)" لاختيار منصات التعلم التزامني في بيئات التعليم العالي ذات البنية التحتية المحدودة. ويتم تطبيق هذا الإطار من خلال تحليل مقارن شامل لمنصات Zoom و Google Meet و Microsoft Teams، مع مراعاة معمارية الاتصالات الخاصة بها، وآليات التكيف مع عرض النطاق الترددي، والإمكانيات التدريسية، والتكامل مع أنظمة إدارة التعلم، ومتطلبات النشر، والملاءمة التشغيلية في ظل ظروف الشبكة غير المستقرة. كما يتضمن التحليل واقع البنية التحتية للجامعات الليبية، بما في ذلك الانقطاع غير المنتظم للتيار الكهربائي، والتذبذب في أداء شبكات الهاتف المحمول، ومحدودية التراخيص المؤسسية، والاعتماد الواسع على إنترنت الهاتف المحمول. وتشير النتائج إلى أن منصة Zoom تقدم الدعم الأقوى للتعلم التفاعلي والتعاوني، بينما توفر منصة Google Meet سهولة وصول وكفاءة أعلى في استهلاك النطاق الترددي للتدريس واسع النطاق، وتوفر منصة Microsoft Teams التكامل المؤسسي الأكثر شمولاً من خلال منظومة Microsoft 365. وأخيراً، يقترح البحث إطار عمل تطبيقي لدعم اتخاذ القرار بالجامعات، يضمن اختيار منصات التعلم الافتراضي بناءً على مدى ملاءمتها للمتطلبات التعليمية، والظروف التشغيلية للبنية التحتية، والأولويات المؤسسية.

الكلمات المفتاحية: التعليم الافتراضي، ملاءمة المهمة والتكنولوجيا، المؤتمرات المرئية، التعليم العالي، قيود البنية التحتية

I. Introduction

The rapid evolution of digital communication technologies has fundamentally transformed the delivery of higher education worldwide. Synchronous virtual-learning platforms have evolved from supplementary communication tools into essential educational infrastructure that supports lectures, laboratory demonstrations, collaborative learning, academic meetings, and postgraduate supervision. Their importance became particularly evident during the COVID-19 pandemic, and they continue to constitute an integral component of modern higher education because of their flexibility, accessibility, and support for hybrid learning models [1].

The effectiveness of virtual education, however, depends not only on the availability of communication technologies but also on the degree to which their technical capabilities satisfy the instructional requirements of different teaching activities. Interactive engineering laboratories, postgraduate seminars, collaborative design sessions, and large introductory lectures impose substantially different technological demands. Consequently, selecting an appropriate virtual-learning platform should be regarded as a task-dependent engineering decision rather than a purely administrative or financial choice [2].

Existing comparative studies have primarily evaluated video-conferencing platforms according to usability, user satisfaction, or individual software features, frequently overlooking the

relationship between pedagogical requirements, communication architectures, and infrastructure limitations [3,4]. Furthermore, most published studies have been conducted in regions with stable broadband connectivity, institutional software licensing, and reliable computing resources. Such conditions differ considerably from those encountered in developing countries, where unstable Internet connectivity, recurring power interruptions, limited institutional budgets, and heavy reliance on mobile data substantially influence educational technology adoption [5,6].

To address these challenges, this study adopts the Task–Technology Fit (TTF) framework [2] as a systematic basis for evaluating Zoom, Google Meet, and Microsoft Teams. The analysis integrates pedagogical considerations with networking architecture, adaptive media transmission, bandwidth utilization, learning management system integration, and deployment requirements.

The principal contributions of this study are as follows.

- A structured TTF framework for evaluating synchronous learning platforms under infrastructure-constrained educational environments.
- A comprehensive comparative analysis integrating pedagogical, architectural, and network-performance perspectives across three platforms.
- A practical decision framework that supports universities in selecting platforms according to instructional objectives, available infrastructure, and institutional resources.
- An explicit extension of existing evaluations to incorporate the operational characteristics of Libyan higher education.

The remainder of this paper is organized as follows. Section II introduces the TTF framework. Section III discusses infrastructure constraints in Libya. Section IV examines platform architectures. Section V presents the comparative evaluation. Section VI develops the decision framework and discusses practical implications. Section VII concludes the paper.

II. Task–Technology Fit Framework

The Task–Technology Fit model, originally proposed by Goodhue and Thompson [2], provides a theoretical foundation for evaluating whether the characteristics of a technological system adequately support the requirements of a specific task. Unlike technology acceptance models that primarily explain users' behavioral intentions, TTF emphasizes the correspondence between task requirements and technological capabilities as the principal determinant of system effectiveness. When a technology closely matches task demands, users accomplish their objectives more efficiently and with higher levels of satisfaction. Recent reviews confirm that TTF remains a robust and actively applied lens for evaluating digital-learning technologies, having since been extended to MOOC platforms, automated-feedback systems, and other e-learning environments [7].

Within higher education, instructional activities differ substantially in their technological requirements. Large theoretical lectures primarily demand stable audiovisual communication, efficient bandwidth utilization, and broad accessibility. In contrast, collaborative seminars, laboratory demonstrations, and postgraduate supervision require richer interaction mechanisms including breakout rooms, annotation tools, shared whiteboards, polling systems, and real-time classroom management. Evaluating virtual-learning platforms solely according to software features therefore provides only a partial understanding of their educational suitability [3].

The evaluation framework adopted in this study considers two complementary dimensions. Task characteristics describe the instructional requirements associated with different educational activities, including the degree of learner interaction, collaborative knowledge construction, classroom management complexity, assessment support, and asynchronous

learning continuity. Technology characteristics describe the engineering capabilities of each platform, including communication architecture, media transport mechanisms, congestion-control strategies, adaptive bitrate algorithms, video codec implementation, bandwidth utilization, learning management system integration, deployment requirements, recording mechanisms, and security features.

The overall Task–Technology Fit is determined by analysing the correspondence between these two dimensions. Platforms demonstrating stronger alignment between pedagogical requirements and technological capabilities are expected to provide superior educational performance, particularly in environments where network instability, limited computing resources, and constrained institutional budgets impose additional operational challenges. This integration of educational and engineering perspectives into a unified decision model constitutes the central methodological contribution of the proposed framework.

III. Infrastructure Constraints in Libyan Higher Education

The effectiveness of synchronous virtual learning is strongly influenced by the technological environment in which educational activities are conducted. Libyan universities represent a pertinent example of infrastructure-constrained higher education, experiencing persistent operational challenges that significantly affect the implementation of synchronous online education [5,6]. Recent assessments confirm that, despite government and institutional investment in ICT infrastructure, limited connectivity, inadequate educator training, and socio-political instability continue to constrain the digital transformation of Libyan higher education [6].

Electrical power interruptions remain among the most influential operational constraints. Unlike planned maintenance schedules common elsewhere, electricity outages in Libya occur unpredictably and vary considerably across geographical regions, with no fixed schedule or predictable duration. Such interruptions frequently disrupt synchronous teaching sessions, forcing instructors and students to reconnect repeatedly during live classes [8]. Virtual-learning platforms providing rapid session recovery, efficient reconnection mechanisms, and robust asynchronous recording capabilities therefore become particularly valuable.

Network connectivity presents an additional challenge. Internet access is primarily provided through 4G mobile networks operated by Al-Madar and Libyana, with signal quality and available bandwidth varying considerably according to location, network congestion, and time of day [9]. Communication architectures capable of adaptive bitrate control, packet-loss recovery, and bandwidth optimization consequently offer substantial advantages over systems that maintain constant transmission rates.

Institutional licensing further influences platform selection. Most Libyan universities rely heavily on freely available software because dedicated budgets for commercial educational platforms remain limited, forcing instructors to operate within the functional restrictions of free-tier accounts [5]. Microsoft Teams represents a partial exception, as several universities participate in the Microsoft 365 Education programme that provides institutional access without additional licensing costs. Students' hardware capabilities also contribute to the problem, with many learners depending on low- or mid-range smartphones with limited processing power and constrained mobile-data subscriptions [10].

Table 1 summarizes the key infrastructure parameters that define the operational context for platform selection in Libyan universities.

Table 1: Infrastructure Parameters of the Libyan Higher-Education Environment

Parameter	Condition
Power supply	Irregular and location-dependent; no fixed duration or schedule [11]
Mobile network	4G (Al-Madar / Libyana); inconsistent coverage and signal quality [11]
Institutional licence	Largely absent; free-tier accounts predominate [5]; Teams available via Microsoft 365 Education in some institutions
Data cost	High relative to student income; constrains consumption patterns [11]
Device profile	Low-to-mid-range smartphones; limited processing power and storage [11]

IV. Platform Architecture

The operational performance of synchronous virtual-learning platforms is fundamentally determined by their underlying communication architectures. Although Zoom, Google Meet, and Microsoft Teams provide comparable educational functionalities from the users' perspective, their internal media-transport mechanisms, congestion-control strategies, codec implementations, and deployment models differ considerably. These architectural differences directly influence communication latency, bandwidth utilization, computational overhead, video quality, and service continuity under constrained network conditions [12,13].

A. Zoom Architecture

Zoom employs a proprietary client-server architecture in which media streams are managed through dedicated Multimedia Routing (MMR) servers. While Zoom supports browser-based access, its full functionality and optimal performance are delivered through a native client application, which handles client-side media encoding and decoding prior to transmission to the MMR server. Audio and video streams are transmitted to the MMR server, which performs media routing, synchronization, and session management before forwarding the appropriate streams to participants [12,13].

The platform primarily utilizes the H.264 video codec combined with AES-256-GCM encryption [13,14]. Its centralized session management enables highly stable audiovisual quality even during large conferences. However, published network-measurement studies indicate that Zoom maintains a relatively stable transmission rate even when network quality deteriorates, prioritizing media quality over aggressive bitrate reduction [15]. Consequently, bandwidth consumption remains comparatively high. Furthermore, software installation and periodic updates increase storage utilization and mobile-data consumption on low-specification devices.

B. Google Meet Architecture

Google Meet is implemented using the open Web Real-Time Communication standard and operates directly within modern web browsers, eliminating installation requirements and significantly reducing deployment complexity. Media communication is managed through Selective Forwarding Units (SFUs) distributed across Google's global infrastructure, which selectively forward compressed streams to participants according to network conditions without re-encoding [1].

Google Meet supports VP8, VP9, and AV1 video codecs with SRTP in-transit encryption. Its most important architectural characteristic is the implementation of adaptive congestion-

control algorithms that continuously monitor available network capacity and dynamically adjust transmission bitrate. During severe bandwidth degradation, Google Meet reduces payload by approximately 40% while preserving audio continuity [12,13]. This behaviour minimizes session interruptions despite significant bandwidth limitations, making the platform highly resilient in mobile-network environments.

C. Microsoft Teams Architecture

Microsoft Teams relies on Microsoft's cloud-based communications infrastructure and media processing architecture for secure collaboration services [16]. Teams is designed as an integrated collaboration platform rather than a dedicated conferencing application, with communication services closely integrated with the Microsoft 365 ecosystem, including SharePoint, OneDrive, OneNote, Outlook, and Microsoft Forms.

Teams supports H.264 video codecs with AES-256 encryption available across all licence tiers. A distinguishing characteristic is the independent management of audio and video streams: during network degradation, video transmission may be reduced or temporarily suspended while audio communication continues uninterrupted [13]. The desktop client also leverages hardware-accelerated media encoding and decoding on compatible systems, lowering CPU usage and improving performance on lower-specification devices [12]. Recent engineering work on reinforcement-learning-based bandwidth estimation, validated against real-world Teams call data, underscores that accurately predicting bottleneck-link capacity remains an active research challenge for sustaining perceived audiovisual quality on this platform [17].

D. Architectural Comparison

Although the three platforms provide comparable synchronous communication services, their architectural priorities differ substantially. Zoom emphasizes communication stability and high audiovisual quality through its proprietary client-server infrastructure. Google Meet prioritizes deployment simplicity, bandwidth adaptation, and browser accessibility using the Web Real-Time Communication model. Microsoft Teams combines communication services with institutional collaboration infrastructure, providing comprehensive Microsoft 365 integration while maintaining adaptive communication under varying network conditions. These architectural distinctions form the technical foundation for the comparative evaluation presented in the following section.

V. Comparative Evaluation

This study evaluates the three platforms using the proposed TTF framework across six dimensions that collectively influence the effectiveness of synchronous virtual learning in infrastructure-constrained environments.

A. Interactive Instructional Support

Zoom demonstrates the highest level of instructional interactivity. Its integrated breakout rooms, collaborative whiteboard, live annotation, polling mechanisms, participant management controls, and flexible screen-sharing capabilities enable instructors to implement active-learning strategies with minimal operational complexity. These features are particularly beneficial for laboratory demonstrations, engineering design sessions, and postgraduate seminars where collaboration and immediate feedback constitute essential learning components [18].

Google Meet provides a simplified instructional environment emphasizing ease of use rather than extensive classroom-management functionality. Although recent versions include breakout rooms, polls, hand-raising mechanisms, and Google Workspace co-editing integration, the overall interaction environment remains less comprehensive than Zoom [4]. Microsoft Teams offers the broadest collaborative environment through Microsoft 365

integration, enabling persistent communication channels, assignment distribution via Teams Assignments, Microsoft Forms for in-session polling, shared OneNote Class Notebooks, and collaborative document editing [19]. From the perspective of TTF, Zoom exhibits the strongest alignment with highly interactive instructional activities, whereas Microsoft Teams provides superior support for institution-wide course management.

B. Communication Efficiency Under Infrastructure Constraints

Communication reliability represents one of the most critical evaluation criteria within developing educational environments. Zoom employs proprietary adaptive transmission mechanisms that prioritize audiovisual quality and communication stability, maintaining high-definition media whenever network conditions permit. This strategy provides excellent communication quality [15].

Google Meet demonstrates the highest degree of communication adaptability. Its Web Real-Time Communication-based architecture continuously estimates available network capacity and dynamically modifies transmission bitrate, video resolution, and frame rate. During severe bandwidth degradation, the platform reduces payload by approximately 40% while preserving audio communication, allowing educational activities to continue despite unstable Internet connectivity [12,13]. Microsoft Teams adopts a balanced strategy by independently managing audio and video streams. When bandwidth becomes limited, video quality is reduced or temporarily suspended while audio transmission continues uninterrupted, effectively preserving instructional continuity [13]. Considering Libyan network conditions, Google Meet demonstrates the strongest communication resilience, while Zoom provides superior audiovisual quality whenever sufficient bandwidth is available.

C. Learning Management System Integration

Microsoft Teams demonstrates the highest level of institutional integration owing to its native interoperability with Microsoft 365 Education. Instructors can schedule meetings from Outlook, distribute learning materials through SharePoint, manage assignments using Microsoft Forms, collaborate through OneNote Class Notebook, and maintain centralized file repositories via OneDrive [19]. This ecosystem significantly reduces administrative overhead while supporting comprehensive digital learning environments.

Google Meet integrates efficiently with Google Classroom and other Workspace services, facilitating rapid deployment for institutions already utilizing Google's educational ecosystem [4,20]. Zoom provides interoperability with numerous external learning management systems, including Moodle, Canvas, and Blackboard, through LTI connectors, though these integrations require additional configuration compared with the native ecosystem support provided by Teams.

D. Accessibility and Deployment

Google Meet offers the simplest deployment model, operating entirely through modern web browsers without dedicated software installation. This characteristic is particularly advantageous for students relying on shared computers or mobile devices with limited storage [4]. Zoom requires a standalone desktop or mobile application providing complete functionality, with periodic software updates imposing additional data costs on low-specification devices [12]. Microsoft Teams supports both browser-based and native application access, though the full range of collaborative features remains available primarily through the desktop client [19]. Considering large-scale educational deployment in Libya, Google Meet demonstrates the greatest accessibility and lowest implementation overhead.

E. Security and Privacy

All three platforms implement encrypted media transmission using modern cryptographic protocols. Zoom provides comprehensive meeting-security controls, including waiting rooms, participant authentication, host-managed permissions, and AES-256-GCM encryption, with optional end-to-end encryption per session [14]. Google Meet benefits from Google's cloud-security infrastructure with encrypted communication channels and centralized account management [4,14]. Microsoft Teams inherits Microsoft's enterprise-grade security architecture, including Azure Active Directory authentication, conditional access policies, multi-factor authentication, compliance management, and AES-256 end-to-end encryption available across all licence [14], making Teams the most comprehensive institutional security environment among the evaluated platforms.

F. Overall Task–Technology Fit Assessment

The comparative analysis demonstrates that no single platform consistently outperforms the others across every evaluation criterion. Zoom provides the highest TTF for highly interactive teaching scenarios requiring intensive collaboration and advanced classroom management. Google Meet achieves superior operational performance in bandwidth-constrained environments owing to its browser-based architecture and adaptive communication mechanisms. Microsoft Teams offers the strongest institutional integration through the Microsoft 365 ecosystem, making it particularly appropriate for universities seeking comprehensive digital-learning infrastructures. These findings indicate that virtual-learning platform selection should not be based on feature availability alone but should systematically evaluate the alignment between instructional requirements, technological capabilities, and institutional infrastructure.

Table 2: Comparative Decision Matrix: Zoom, Google Meet, and Microsoft Teams

Feature	Zoom	Google Meet	Microsoft Teams
Client architecture	Proprietary client–server; dedicated MMR servers; full features via native client [12,13]	Browser-based; open WebRTC standard; Selective Forwarding Units (SFUs) [1]	Cloud-based Microsoft communications infrastructure; integrated with Microsoft 365 [16]
Video codec	H.264 [13,14]	VP8, VP9, AV1 (with SRTP encryption)	H.264
Congestion control	Maintains stable transmission rate; prioritizes quality over bitrate reduction [15]	Adaptive; reduces payload by ~40% under severe degradation [12,13]	Independent audio/video management; video reduced or suspended while audio continues [13]
Teaching tools	Breakout rooms, whiteboard, annotation, polling, participant management [18]	Breakout rooms, polls, hand-raising, Workspace co-editing [4]	Teams Assignments, Microsoft Forms polling, OneNote Class Notebook [19]
LMS integration	LTI connectors to Moodle, Canvas, Blackboard;	Google Classroom / Workspace integration [4,20]	Native Microsoft 365 Education: Outlook, SharePoint, OneDrive [19]

	additional configuration required		
Bandwidth consumption	Comparatively high; stable rate maintained even as network quality drops [15]	Most efficient; payload reduced ~40% under constrained bandwidth [12,13]	Balanced; video load reduced first, audio preserved [13]
Encryption	AES-256-GCM; optional end-to-end encryption per session [14]	Encrypted channels via Google cloud-security infrastructure [4,14]	AES-256; Azure AD authentication, MFA, compliance management [14]
Recording & Archiving	Supports cloud-based as well as native, secure local desktop recording (MP4) without requiring third-party software or active internet uploading.	Cloud-only recording directly to Google Drive (requires upload bandwidth). Excluded from the free tier and when using virtual rooms [4].	Cloud-only recording to OneDrive/SharePoint with automatic AI-driven transcription, speaker identification, and closed captions [4].
Free-tier limits	Free-tier accounts predominate given limited institutional budgets [5]	Free-tier accounts predominate [5]	Available via Microsoft 365 Education at no added cost in several institutions [5]
Recommended use case	Interactive, collaborative courses: labs, postgraduate supervision, project-based learning	Bandwidth-limited settings; browser-based access; large-scale lectures	Institution-wide digital transformation via Microsoft 365 integration

VI. Decision Framework and Discussion

A. Platform Selection Decision Matrix

Table 2 presents the comparative results of the analysis across all three platforms. The results confirm that the selection among the platforms depends on the instructional task, the institutional licence portfolio, and the local infrastructure conditions.

From Table 2, it can be seen that Zoom outperforms the other platforms on active-learning tool availability and video quality under sufficient bandwidth. Google Meet outperforms the others on installation overhead and bandwidth efficiency under constrained conditions. Microsoft Teams outperforms the others on LMS integration, assessment management, and institutional security. This confirms that no single platform is universally superior; the optimal choice depends on the teaching context and institutional infrastructure.

B. Platform Selection Guidelines

Based on the comparative evaluation, each platform demonstrates distinct operational strengths corresponding to specific educational scenarios. Zoom is most suitable for courses requiring

intensive interaction, collaborative activities, engineering laboratories, postgraduate supervision, and project-based learning. Google Meet represents the most appropriate solution for institutions experiencing bandwidth limitations or relying heavily on browser-based access, particularly for large-scale lectures and general student access. Microsoft Teams is particularly advantageous for universities implementing institution-wide digital transformation initiatives, where integration with Microsoft 365 enables unified identity management, collaborative document editing, assignment distribution, and centralized communication throughout the academic lifecycle.

C. Implications for Higher Education

The findings of this study have several practical implications. First, platform-selection policies should consider communication architecture alongside instructional functionality, as adaptive bitrate mechanisms and deployment requirements directly influence learning continuity within infrastructure-constrained environments. Second, investment decisions should prioritize instructional alignment rather than software popularity, since institutions frequently adopt platforms based on licensing availability without evaluating pedagogical compatibility. Third, universities with limited resources may improve educational effectiveness by matching different instructional activities to different platforms rather than enforcing a single institutional standard. Finally, integrating TTF analysis into institutional technology planning enables evidence-based decision making while reducing operational risks associated with large-scale software deployment.

D. Limitations of the Study

Although the proposed framework provides a comprehensive evaluation methodology, several limitations should be acknowledged. First, the analysis focuses exclusively on three widely adopted platforms; other emerging systems may exhibit different architectural characteristics and educational capabilities. Second, the evaluation primarily considers higher-education environments similar to those in Libya, and institutional priorities may differ in regions possessing more advanced digital infrastructure. Third, the study relies on comparative technical analysis and published platform characteristics rather than large-scale empirical classroom experiments. Future validation through controlled educational deployments would further strengthen the proposed framework.

VII. Conclusion and Future Work

This study presented a Task–Technology Fit-based evaluation framework for systematically assessing synchronous learning platforms within infrastructure-constrained higher-education environments. Unlike conventional feature-oriented comparisons, the proposed framework integrates instructional requirements with communication architecture, bandwidth adaptation, deployment characteristics, learning management system integration, and institutional operational constraints.

The comparative evaluation demonstrated that each platform exhibits distinctive strengths corresponding to different instructional contexts. Zoom achieved the highest TTF for interactive and collaborative learning environments owing to its advanced classroom-management capabilities and stable communication architecture. Google Meet demonstrated superior adaptability under bandwidth-constrained conditions through its browser-based implementation and efficient adaptive transmission mechanisms. Microsoft Teams provided the strongest institutional integration by combining synchronous communication with comprehensive Microsoft 365 collaboration services and enterprise-grade security available across all licence tiers.

The findings further demonstrate that communication architecture should be regarded as an integral component of educational technology evaluation. Network protocols, adaptive bitrate algorithms, deployment models, and cloud-service integration directly influence instructional continuity and learner engagement. Although the analysis is presented within the context of Libyan higher education, the proposed evaluation methodology is applicable to many developing countries experiencing similar infrastructural challenges.

Future research may extend the proposed framework in several directions. Large-scale empirical studies involving instructors and students from multiple universities could validate the evaluation model under real instructional conditions. Additional platforms and emerging communication technologies, including AI-assisted conferencing systems and extended-reality educational environments, may be incorporated into the framework. Objective network-performance measurements including latency, jitter, packet loss, and Quality of Experience (QoE) metrics could establish a more comprehensive engineering-based assessment model. Finally, machine-learning techniques may be employed to develop adaptive recommendation systems capable of automatically selecting the most appropriate platform according to institutional infrastructure, course characteristics, and available network resources.

References

1. García-Morales, V. J., Garrido-Moreno, A., & Martín-Rojas, R. (2021). The transformation of higher education after the COVID disruption: Emerging challenges in an online learning scenario. *Frontiers in Psychology*, 12, Article 616059.
2. Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly*, 19(2), 182–216.
3. Bower, M. (2008). Affordance analysis: Matching technologies with learner requirements. *Educational Media International*, 45(1), 3–15.
4. Grynshyna, M., Boiko, T., Boklan, M., Husakova, N., & Pozniak, A. (2023). Comparative analysis of ways to integrate Microsoft Teams, Zoom, Google Meet into the educational process of higher education institutions of Ukraine. *Journal of Higher Education Theory and Practice*, 23(2), 1–12.
5. Kenan, T., Pislariu, C., & Elzawi, A. (2014). Trends, opportunities and challenges of e-learning in Libyan higher education. *International Journal of Digital Information and Wireless Communications*, 4(1), 121–131.
6. Masuud, M. (2025). Development of digital education in Libya: Progress, challenges, and future directions. *International Journal of Educational Digital Learning*, 3(5), 211–219.
7. Ulfa, S., Surahman, E., Fatawi, I., & Hirashima, T. (2024). Task-technology fit analysis: Measuring the factors that influence behavioural intention to use the online summary-with automated feedback in a MOOCs platform. *Electronic Journal of e-Learning*, 22(1), 1–15.
8. Elemam, R. F., El Swiah, J. M., Durda, A. O., & Hegazy, N. N. (2024). Cross-sectional study of attitudes toward online continuing dental education in Libya during the COVID-19 pandemic. *PLOS ONE*, 19(1), Article e0296783.
9. Masoud, F. (2023). Visual Basic platform to evaluate Libyana Almadar performance. *Bani Waleed University Journal of Humanities and Applied Sciences*, 8(3), 93–98.
10. Hewson, E. R. F., & Chung, G. W. (2021). Beyond the VLE: Transforming online discussion and collaboration through Microsoft Teams. *The International Journal of Management Science and Business Administration*, 7(3), 37–45.

11. Alshref, H. H. M., Al-Sanjary, O. I., & Johar, M. G. M. (2024). A model for the adoption of e-learning in Libyan higher education institutions. *International Journal of Business Society*, 8(6), 941–951.
12. Chang, H., Varvello, M., Hao, F., & Mukherjee, S. (2021). Can you see me now? A measurement study of Zoom, Webex, and Meet. In *Proceedings of the 21st ACM Internet Measurement Conference (IMC)* (pp. 216–228). ACM.
13. MacMillan, K., Mangla, T., Saxon, J., & Feamster, N. (2021). Measuring the performance and network utilization of popular video conferencing applications. In *Proceedings of the 21st ACM Internet Measurement Conference (IMC)* (pp. 229–244). ACM.
14. Avcı, H., Yıldırım, E., & Akdağ, E. S. (2025). Ensuring video conferencing applications security: Security, privacy, challenges and risks. *Current Trends in Computing*, 3(1), 28–43.
15. Kumar, R., Nagpal, D., Naik, V., & Chakraborty, D. (2022). Comparison of popular video conferencing apps using client-side measurements on different backhaul networks. *arXiv*. <https://arxiv.org/abs/2210.09651>
16. Microsoft. (2024). Security guide for Microsoft Teams. Microsoft Learn. <https://learn.microsoft.com/en-us/microsoftteams/teams-security-guide>
17. Khairy, S., Yan, F. Y., Inglis, S., Mittag, G., Niu, Z., Golestaneh, M., Gopal, V., Ameri, E., & Cutler, R. (2024). ACM MMSys 2024 bandwidth estimation in real-time communications challenge. In *Proceedings of the 15th ACM Multimedia Systems Conference (MMSys '24)* (pp. 1–7). ACM.
18. Kohnke, L., & Moorhouse, B. L. (2022). Facilitating synchronous online language learning through Zoom. *RELC Journal*, 53(1), 296–301.
19. Microsoft. (n.d.). Teams desktop client features. Microsoft Learn. Retrieved August 24, 2026, from <https://learn.microsoft.com/en-us/microsoftteams/teams-desktop-client-features>
20. Alturki, U. T., & Aldraiweesh, A. (2022). Adoption of Google Meet by postgraduate students: The role of task technology fit and the TAM model. *Sustainability*, 14(23), Article 15765.

Compliance with ethical standards***Disclosure of conflict of interest***

The authors declare that they have no conflict of interest.

Disclaimer/Publisher's Note: The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of JLABW and/or the editor(s). JLABW and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.