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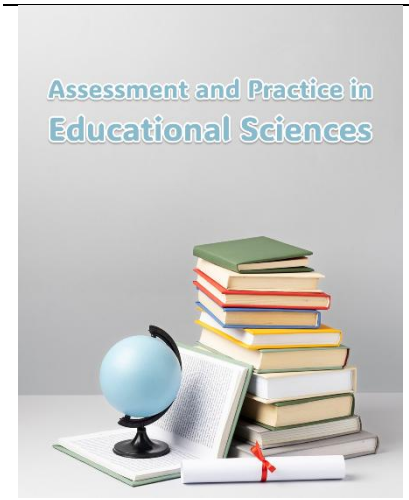

Enhancing E-Learning Engagement and Effectiveness: A Post-Pandemic Evaluation of German Language Students' Perceptions and Outcomes

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ABSTRACT

The COVID-19 pandemic precipitated a rapid global shift to online education, challenging traditional pedagogical practices, particularly in language learning, which relies heavily on communicative interaction. This study investigates post-pandemic experiences of 180 undergraduate German language students in Tehran who had participated in both pre-pandemic in-person and post-pandemic online learning. Using a structured Likert-scale questionnaire, the study assessed student satisfaction, engagement, communication, and perceived learning outcomes across three domains: student experience, learning outcomes, and communication quality. Results indicate high levels of satisfaction with instructor communication and learning flexibility, with 91% of students rating instructor interactions positively and 57.8% expressing a preference for online or hybrid formats. While peer interaction in digital environments was less robust, strong correlations emerged between communication satisfaction and learner motivation, underscoring the importance of well-structured digital interaction tools. The findings highlight the benefits of post-pandemic online education, including schedule autonomy, content accessibility, and self-paced learning, while identifying persistent challenges in fostering spontaneous peer engagement. The study situates its analysis within the Community of Inquiry framework, emphasizing the interdependence of teaching, social, and cognitive presence in creating meaningful online learning experiences. By providing empirical evidence on student perceptions in a hybrid post-pandemic context, the research contributes to ongoing discussions about effective e-learning design, learner autonomy, and culturally sensitive pedagogical strategies. The study concludes that hybrid models, when paired with high-quality communication channels and digital infrastructure, can sustain student motivation and engagement, offering practical insights for instructors, instructional designers, and policymakers seeking to develop resilient, learner-centered language education programs. Future research should expand on these findings using longitudinal designs, diverse institutional settings, and performance-based assessments of language proficiency to further optimize online and hybrid learning strategies.

Keywords: E-Learning, Engagement, German Language, Post-Pandemic, Hybrid Learning

Introduction

The global education landscape has undergone an unprecedented transformation in the wake of the COVID-19 pandemic, reshaping how institutions conceptualize learning, teaching, and interaction. The abrupt transition from traditional classroom settings to online and hybrid modalities compelled educators to re-evaluate pedagogical frameworks and technological infrastructures that support effective instruction. In this context, e-learning emerged not merely as a contingency solution but

as a sustainable educational paradigm that continues to define post-pandemic higher education. The evolution of digital learning environments has thus prompted new academic inquiries into learner engagement, instructional design, and the long-term integration of digital technologies in diverse educational contexts, including language education, which traditionally relies on communicative and collaborative experiences (1, 2).

E-learning, broadly defined as the use of electronic technologies to access educational curricula outside a traditional classroom, has been recognized for its potential to democratize access, promote flexibility, and support self-regulated learning. Yet its benefits are tempered by persistent challenges related to infrastructure, learner motivation, and pedagogical adaptation (3, 4). According to recent global assessments, while online learning enhanced educational continuity during the pandemic, it also magnified disparities between students with differing digital access and literacy levels. This "digital divide" underscores the necessity of understanding both the benefits and limitations of e-learning across cultural and disciplinary boundaries (1). Within the specific field of language learning—where interaction, immediacy, and feedback are essential—these challenges have been particularly complex, demanding innovative frameworks that balance autonomy with communication and community (2, 5).

Several recent studies have examined e-learning implementation in higher education from the standpoint of institutional readiness, pedagogical effectiveness, and student satisfaction. Clarin and Baluyos (2022) observed that universities in developing contexts encountered extensive difficulties during the sudden digital transition, including unstable internet connectivity, insufficient instructor training, and limited technological infrastructure (3). These findings align with the experiences of Iranian institutions, where faculty and students faced obstacles in adapting conventional classroom models to virtual environments (6). Similarly, Qazi et al. (2024) reported that barriers to e-learning adoption in emerging economies are multidimensional, encompassing technological, cultural, and institutional dimensions that hinder smooth integration into existing academic systems (4). Such insights demonstrate that successful digital transformation in education requires not only hardware investment but also a shift in pedagogical culture and faculty competencies.

In the Iranian context, e-learning was initially introduced as a supplementary mode of instruction, but the pandemic accelerated its adoption into mainstream education. Studies have revealed a spectrum of learner responses: while many students appreciated the flexibility and accessibility of online education, others struggled with decreased motivation and limited peer interaction (7). For instance, Ghalavand (2024) found that medical students' intention to continue using e-learning after the pandemic was strongly linked to perceived ease of use and satisfaction with communication channels. This confirms that the sustainability of digital learning depends on the psychological and communicative dimensions of learner experience, not solely on technological adequacy. From a broader pedagogical perspective, Norouzi and Nazempour (2024) emphasized that fostering a positive university image in e-learning contexts requires active learner participation and co-creation of value through digital engagement (8). Thus, the success of online education is contingent upon meaningful interaction and emotional connection, which reinforce student loyalty and satisfaction.

The integration of digital technology in education has also redefined the boundaries of instructional design. Pei-Chen and Hsing Kenny (2025) proposed a media-richness-based model for multimedia design in e-learning, emphasizing the need to align instructional materials with cognitive load and sensory engagement principles (9). Their research underscores that the effectiveness of online education is determined not merely by content delivery but by the richness of multimodal interaction that supports learners' diverse cognitive styles. Parallel evidence from Gupta et al. (2024) suggests that e-learning environments can significantly enhance creativity and academic performance when digital tools are used to foster participatory and reflective learning (10). Such findings highlight the dual role of technology as both a medium and a catalyst for cognitive engagement.

Equally significant is the rise of artificial intelligence (AI) as a transformative force in online education. Halkiopoulos and Gkintoni (2024) argued that AI-driven adaptive assessment systems informed by cognitive neuropsychology can personalize instruction and optimize learning pathways in real time (11). These systems can analyze learner behavior, monitor progress, and dynamically adjust content difficulty, thereby enhancing the efficiency and inclusiveness of e-learning environments. Complementing this perspective, Group (2024) emphasized the potential of AI-assisted platforms to promote active learning by scaffolding interaction, feedback, and learner autonomy (12). Collectively, these technological innovations reflect an emerging pedagogical ecosystem where machine intelligence, human facilitation, and learner agency coalesce to produce more individualized and responsive educational experiences.

In addition to technological and design factors, the psychological and social dimensions of e-learning remain central to student outcomes. Research by Hizriansyah et al. (2024) revealed that self-directed e-learning interventions can significantly improve mental well-being and resilience among health workers in post-pandemic settings (13). This highlights the broader potential of digital learning environments to nurture not only cognitive but also emotional competencies—an aspect particularly relevant for language learners, whose performance often depends on confidence, motivation, and communicative comfort. Likewise, Sadeghi (2024) demonstrated that gamified e-learning modules in marine ecology education enhanced Iranian students' engagement and comprehension, suggesting that gamification can increase intrinsic motivation through interactive and challenge-based mechanisms (14). Such insights resonate strongly with the concept of "flow" in online learning, where enjoyment and immersion reinforce persistence and achievement.

The pedagogical discourse has also expanded toward blended and hybrid approaches that integrate the strengths of online and face-to-face education. Zare et al. (2024) found that blended learning models combining synchronous and asynchronous elements significantly improved academic performance and self-efficacy among Iranian university students (15). These models fostered an optimal balance between flexibility and structured interaction, demonstrating that the coexistence of digital and in-person learning modalities can enhance both cognitive and social engagement. Puniatmaja et al. (2024) similarly reported that digital literacy serves as a powerful predictor of e-learning success, mediating the relationship between technological accessibility and learning outcomes (16). As a result, the cultivation of digital competencies has become a central priority in higher education reform, ensuring that students possess not only technical proficiency but also critical and creative capacities for navigating digital ecosystems.

Despite these advancements, the implementation of online education continues to encounter systemic and contextual barriers. Mohammadi and Taghipour (2024) documented that faculty in Tabriz University perceived major challenges in using e-learning management systems during the pandemic, including inadequate institutional support, assessment difficulties, and time-management issues (6). These challenges echo the findings of Clarin and Baluyos (2022), who underscored the crucial need for continuous professional development programs to prepare educators for digital pedagogies (3). Without consistent institutional investment in infrastructure and training, even the most advanced technological solutions risk remaining underutilized.

Another key dimension in post-pandemic education is student engagement—a multifaceted construct encompassing behavioral, cognitive, and emotional involvement. Poon et al. (2024) introduced an interaction model emphasizing that e-learning engagement and effectiveness are driven by reciprocal communication between students, instructors, and digital systems (17). Their findings reaffirm the necessity of designing online environments that facilitate two-way feedback, peer collaboration, and adaptive communication tools. Within Iranian higher education, similar issues have been identified in studies assessing students' and teachers' perspectives regarding e-learning quality during the pandemic. Zarifsanaiey et al. (2024) concluded that while e-learning offered flexible access to educational content, deficiencies in interaction and assessment

mechanisms undermined learning satisfaction (5). Therefore, addressing the human element in online education remains an ongoing challenge that requires culturally sensitive and pedagogically grounded solutions (2).

Recent theoretical and empirical advancements collectively suggest that the future of e-learning depends on achieving harmony between technological innovation, pedagogical integrity, and socio-emotional support. Oulamine et al. (2025) argued that the evolution of e-learning in higher education is now entering a stage of consolidation, characterized by the refinement of hybrid pedagogies and the institutionalization of digital literacy frameworks (1). Similarly, Ghalavand (2024) emphasized that learners' continuance intention toward e-learning is highly dependent on post-pandemic system reliability and the perceived value of instructor-student communication (7). These observations highlight the growing recognition that digital education must evolve beyond emergency solutions toward sustained, research-driven strategies that cultivate engagement, inclusivity, and lifelong learning competencies.

As higher education systems continue to adapt to post-pandemic realities, e-learning has emerged as a catalyst for pedagogical innovation and institutional resilience. It has also opened pathways for interdisciplinary collaboration, enabling educators to integrate AI-driven analytics, multimedia design, and gamified approaches to enrich learner experiences. Yet, at the heart of these transformations lies the need to preserve the relational and interactive essence of education, particularly in disciplines like language learning that depend on authentic communication. Understanding how learners perceive and engage with digital environments is thus pivotal for shaping effective instructional design and policy.

Accordingly, the present study aims to evaluate the post-pandemic experiences of undergraduate German language students in Iran, focusing on their perceptions of satisfaction, engagement, communication quality, and learning outcomes in online and hybrid environments, with the ultimate goal of identifying mechanisms that enhance e-learning effectiveness and sustainability.

Methods and Materials

Research Design

This study employs a cross-sectional design to evaluate post-pandemic perceptions of online and traditional learning among German language students. The analysis focuses on a single group of 180 students who experienced both instructional modes (in-person pre-pandemic and online post-pandemic). This within-subject approach captures shifts in satisfaction and engagement while controlling for individual differences, as participants served as their own controls across time periods. Data were collected via a structured questionnaire administered in 2023.

Participants

Participants comprised 180 undergraduate German language students from Islamic Azad Universitis in Tehran (aged 21–35; 52% female, 48% male). All had completed at least one semester of in-person instruction pre-pandemic (2019–2020) and one semester of online learning post-pandemic (2021–2023).

Instrument and Data Collection

A 6-point Likert-scale questionnaire (1 = Extremely dissatisfied, 6 = Extremely satisfied) assessed three domains:

- Student Experience: Preference for learning format, platform usability, flexibility, and resource access.
- Learning Outcomes: Perceived knowledge retention, motivation, and content applicability.
- Communication: Quality of peer and instructor interaction.

The communication domain specifically addressed the perceived effectiveness of peer interaction during virtual group work, discussions, and collaborative tasks. The questionnaire was distributed electronically through the university's learning management system (LMS). To ensure validity, the instrument was piloted with 20 students (excluded from the final sample), demonstrating high internal consistency (Cronbach's $\alpha = 0.89$)

Data Analysis

The quantitative data analysis employed a multi-stage approach to comprehensively evaluate student responses. Descriptive statistics, including means, standard deviations, and response frequencies, were calculated for each item on the Likert scale. Inferential statistical tests were used to examine differences between pre-pandemic and post-pandemic learning experiences. Pearson correlation coefficients were calculated to explore the relationship between satisfaction in communication and perceived learning outcomes. Qualitative analysis of open-ended responses identified recurring patterns in accordance with the Community of Inquiry framework.

Findings and Results

Satisfaction and Preference Outcomes

Analysis revealed significant satisfaction with digital learning formats. Instructor communication received the highest approval, with 91% of students rating it as extremely satisfactory. The overall preference for e-learning or hybrid formats was notable, with 57.8% selecting online as their preferred mode of learning. Flexibility was a common reason for this preference. The distribution of responses demonstrated strong satisfaction with communication-related items and greater variability in platform and resource evaluations.

Table 1 presents the detailed distribution of student responses across all questionnaire items, offering a comparative view of satisfaction levels for each domain.

Table 1. Distribution of Likert-scale Responses for All Questionnaire Items (N = 180)

Questions	6	5	4	3	1	2	overall outcome
Student preference: e-learning or face-to-face teaching?	104				76		180
Assessment of the university's e-learning platform during the pandemic from the students' perspective	18	14	22	45	27	54	180
The ability of students to apply the content of the online courses in practice	22	32	40	41	14	31	180
Effect of the e-learning platform on students' knowledge of teaching topics	31	41	48	27	13	20	180
Providing resources for effective e-learning at University	2	14	29	38	58	39	180
Flexible learning on the e-learning platform: space and time independence	63	45	25	22	9	16	180
Impact of the University's e-learning platform on communication with other students	54	49	43	16	5	13	180
The change in students' interest in topics and content during the pandemic	14	63	49	20	22	12	180
The influence of the University's e-learning platform on communication between students and lecturers	68	56	40	9	2	5	180
Motivation of the students to regularly engage with the content during the semester through e-learning	15	18	27	43	32	45	180
overall outcome	391	332	323	261	258	235	1800

The results show that students are generally satisfied with their e-learning experience. The answer option "Extremely satisfied" is the most frequently chosen option for the following questions.

- Influence of the e-learning platform of the Islamic Azad University on communication between students and lecturers: More than 91% of students agree that the Islamic Azad University's e-learning platform has a positive influence on communication between students and lecturers.
- Impact of the Islamic Azad University's e-learning platform on communication with other students: More than 81% of students agree that the Islamic Azad University's e-learning platform has a positive influence on communication with other students.
- The change in students' interest in topics and content during the pandemic: 70% of students interest in topics and content during the pandemic changed positively.
- Effect of the e-learning platform on students' knowledge of teaching topics: 66% of students say they are satisfied with the university's e-learning platform during the pandemic.
- Flexible learning on the e-learning platform: space and time independence: 66% of students say they are satisfied with the e-learning platform during the pandemic and can learn flexibly according to their own schedules.
- Student preference: e-learning or face-to-face teaching: 57% of students say they are satisfied with the university's e-learning offerings.

The questionnaire included three major components, and students' satisfaction with the learning platform is evident in each component.

Engagement and Interaction Metrics

The analysis showed that peer interaction received moderate ratings in the online format, while instructor communication and flexibility were rated more positively. This contrast suggests that while digital environments may effectively support teacher-student interaction, they still present challenges for fostering meaningful peer engagement. Meanwhile, students reported higher satisfaction with the quality of homework submitted online, indicating that digital tools may offer more opportunities for content refinement and self-paced work. Responses to the item on learning flexibility were strongly positive, with many participants expressing appreciation for the ability to manage their schedules and learning pace independently.

Motivational and Psychological Correlates

A strong positive relationship was identified between communication satisfaction and self-reported motivation. However, resource availability remained a persistent challenge, which may have limited motivation gains for some learners.

Effect Size Interpretation

Quantitative interpretation of the results confirmed the robustness of these findings. Communication satisfaction was notably high, indicating substantial improvements over traditional formats. Peer interaction, while still lagging in virtual settings, accounted for significant variance in engagement scores. Students also expressed a strong preference for scheduling autonomy, suggesting flexibility as a critical benefit of digital learning.

Interpretation of Core Patterns

Three key patterns emerged from the analysis. First, students consistently cited enhanced communication and flexibility as advantages of online learning. Second, limitations in peer interaction and digital resources echoed challenges commonly reported in virtual language education. Third, communication quality was a strong predictor of learner motivation, reinforcing the need for well-designed interaction tools within digital platforms.

Discussion and Conclusion

The findings of this study illuminate how post-pandemic e-learning has reshaped learners' perceptions of engagement, communication, and flexibility in higher education, particularly among students of foreign languages. The high levels of satisfaction reported by participants—especially regarding instructor communication and schedule flexibility—suggest that e-learning, when properly structured, can support effective learning outcomes even in interaction-intensive disciplines such as German language education. This observation aligns with previous research emphasizing that online education, when guided by clear pedagogical design and interactive digital tools, can enhance student motivation and academic achievement (10, 16). The results demonstrate that students not only adapted to online education but, in many cases, preferred hybrid or fully digital formats due to their autonomy, accessibility, and convenience. This reflects a fundamental transformation in learner expectations and confirms that e-learning has moved from an emergency response to a sustainable and preferred educational modality (1, 2).

A key result emerging from the analysis is the strong positive correlation between communication quality and learner motivation. Students who rated instructor-student communication as effective also reported higher engagement and satisfaction. This finding reinforces the theoretical principles of interactive and social constructivist learning, which highlight the significance of dialogue and feedback in sustaining motivation and participation (5, 17). It also echoes the insights of Ghalavand (2024), who found that Iranian medical students' intention to continue e-learning post-pandemic depended primarily on their perception of communication reliability and system usability (7). Similarly, Norouzi and Nazempour (2024) demonstrated that perceived interaction and co-creation of value significantly influence the image of universities that operate in virtual education environments (8). In the current study, communication emerged as the pivotal determinant of satisfaction, suggesting that well-designed e-learning systems can effectively replicate the interactive dynamics of face-to-face education when instructors use multimodal strategies—such as video discussions, real-time feedback, and collaborative digital forums—to maintain social presence.

While communication with instructors was rated highly, peer interaction was identified as a relatively weaker dimension of students' digital experience. This imbalance points to the persistent difficulty of fostering spontaneous social exchange in online environments, particularly in language courses where interpersonal dialogue is essential for linguistic fluency. The findings mirror the conclusions of Culduz (2024), who argued that although e-learning increases accessibility and self-paced learning, it may inadvertently reduce opportunities for natural peer communication and collaborative practice (2). Moreover, Qazi et al. (2024) observed similar challenges in Pakistani universities, where students noted limited peer collaboration as one of the principal barriers to effective e-learning (4). The consistency of these findings across contexts underscores a structural limitation in digital pedagogy: online platforms often prioritize content delivery over community building, leading to reduced social presence and peer-to-peer interaction. To address this, institutions must integrate synchronous components, such as breakout discussions and interactive projects, to sustain communicative competence and foster collaborative learning environments.

The preference of 57.8% of students for online or hybrid learning highlights an attitudinal shift that signals acceptance of digital learning as a legitimate and effective educational mode. This result complements global trends reported by Oulamine et al. (2025), who argued that e-learning has transitioned from an emergency measure into a structural pillar of higher education (1). Students' enthusiasm for flexibility and autonomy also resonates with findings by Zare et al. (2024), who demonstrated that blended learning models enhance both performance and satisfaction by combining synchronous guidance with asynchronous independence (15). The emphasis on flexibility as a motivational factor further supports the notion that post-

pandemic learners value self-regulation and time management as key competencies in digital environments (16). These insights collectively suggest that universities must move beyond the binary opposition between traditional and online modes, instead embracing hybrid ecosystems that merge structure with adaptability.

Technological and pedagogical design also play a crucial role in determining learning outcomes. The present study's results, which indicated that students were highly satisfied with the clarity and usability of learning platforms, confirm the necessity of robust digital infrastructures and intuitive user interfaces. Studies by Mohammadi and Taghipour (2024) highlighted that lack of technical support and poorly designed e-learning management systems were among the most significant barriers perceived by Iranian faculty during the pandemic (6). These deficiencies often led to time-consuming administrative burdens, reduced feedback quality, and lower instructor motivation. By contrast, when digital tools are designed with pedagogical intentionality and accessibility in mind, they can substantially enhance communication, participation, and learning continuity (3). Therefore, the current study's positive outcomes can be attributed in part to improved digital readiness and institutional investment in post-pandemic infrastructures.

The positive relationship between learner satisfaction and motivation identified in this research also aligns with the self-determination framework, which emphasizes autonomy, competence, and relatedness as core drivers of intrinsic motivation. Gamified and multimedia-based learning designs are particularly effective in addressing these needs. Sadeghi (2024) found that gamification in marine ecology e-learning significantly enhanced engagement among Iranian maritime students by introducing interactive challenges and reward mechanisms (14). Similarly, Pei-Chen and Hsing Kenny (2025) argued that multimedia instructional designs grounded in media richness theory can accommodate learners' cognitive preferences and improve comprehension (9). The present findings, which demonstrate high engagement and preference for flexible learning, reflect the combined influence of these motivational and cognitive factors. Students valued not only the freedom to learn at their own pace but also the quality of the digital interfaces that mediated their interaction with content and instructors.

Another noteworthy dimension revealed by the study is the alignment between digital autonomy and emotional well-being. A growing body of research suggests that e-learning environments can promote self-efficacy, confidence, and resilience when properly scaffolded (13). Hizriansyah et al. (2024) found that self-directed e-learning interventions improved post-pandemic well-being among healthcare professionals by fostering a sense of agency and control over learning trajectories. These findings parallel the current study's observation that students appreciated the independence afforded by digital education, which enabled them to manage academic demands alongside personal obligations. However, such autonomy also requires adequate self-regulation skills and emotional maturity; without these, learners may experience disengagement or cognitive overload. Thus, the success of e-learning depends on balancing autonomy with consistent pedagogical support and clear guidance mechanisms (12).

Technological advancement—particularly the incorporation of artificial intelligence and adaptive learning systems—has also contributed to enhancing engagement and assessment accuracy in digital environments. The systematic analysis by Halkiopoulos and Gkintoni (2024) underscored how AI-powered adaptive systems can personalize learning pathways and assess performance based on cognitive-neuropsychological data (11). Integrating such tools into language learning could help overcome traditional limitations of standardized evaluation by providing real-time feedback and individualized progression routes. Although this study did not directly measure the impact of AI on learner outcomes, the high satisfaction rates associated with communication efficiency may indirectly reflect the growing influence of intelligent learning management systems that mediate interaction and assessment. This corresponds to the findings of Gupta et al. (2024), who demonstrated that data-driven personalization enhances creativity, cognitive engagement, and perceived learning effectiveness (10).

Despite the positive outcomes observed, the study also identified enduring gaps that must be addressed to optimize e-learning effectiveness. One persistent challenge concerns the unequal quality of peer engagement. Even as technological systems evolve, the human component of learning—the informal exchange of ideas, spontaneous discussions, and collaborative task-solving—remains difficult to replicate online. Zarifsanaiey et al. (2024) emphasized that both students and instructors identified interaction quality as the weakest component of e-learning during the pandemic, attributing it to insufficient synchronous communication opportunities and limited emotional connection (5). The findings of the present study echo this concern: while learners valued flexibility and instructor accessibility, they reported that peer communication felt impersonal or fragmented. This highlights a critical design consideration for future e-learning systems—one that extends beyond content management to social architecture, emphasizing relational presence and collective meaning-making (2).

Finally, the results underscore a key pedagogical insight: the effectiveness of e-learning is contingent not merely on technology but on the interaction between human, social, and technical elements. As Oulamine et al. (2025) argued, the current phase of e-learning development represents a convergence of technological sophistication and pedagogical adaptation (1). The challenge for educators lies in maintaining equilibrium between automation and personalization, ensuring that technology amplifies rather than replaces the human experience of learning. Group (2024) similarly emphasized the importance of active learning structures that empower students to construct knowledge collaboratively within digital ecosystems (12). In the context of language education, this entails designing e-learning frameworks that preserve the spontaneity, empathy, and cultural exchange intrinsic to communicative competence.

Collectively, these findings reaffirm that e-learning has matured into an integral and enduring component of higher education. The evidence indicates that when supported by clear instructional design, reliable communication channels, and culturally responsive pedagogies, digital learning can match or even surpass traditional modes in fostering engagement, satisfaction, and motivation (7, 15). At the same time, the human dimension of interaction remains indispensable—particularly in disciplines like language learning, where dialogue is not only a tool for instruction but the very medium of learning.

This study, while comprehensive in its evaluation of student perceptions, was limited by its reliance on self-reported data. The subjective nature of satisfaction and engagement metrics may introduce bias influenced by personal attitudes or transient experiences. Additionally, the study's sample was geographically restricted to Iranian universities in Tehran, which may limit the generalizability of findings to other cultural or institutional contexts. The cross-sectional design captured perceptions at a single point in time, thereby preventing causal inferences regarding the relationship between communication quality and learning outcomes. Moreover, the absence of objective performance assessments restricts the ability to correlate perceived engagement with actual academic achievement.

Future studies should incorporate longitudinal designs to observe how learner engagement, satisfaction, and academic performance evolve across multiple semesters in hybrid environments. Expanding the sample to include students from different cultural and linguistic backgrounds could illuminate how socio-cultural factors shape e-learning adaptation. Further research should also investigate the specific affordances of AI-driven personalization tools and gamified learning systems in promoting motivation and interaction. Mixed-method approaches combining quantitative performance data with qualitative interviews could provide richer insights into how communication and community building function in virtual learning ecosystems.

Institutions should prioritize the integration of pedagogical training programs that equip instructors with skills in digital facilitation, multimedia design, and virtual communication. Universities must invest in robust and user-friendly learning management systems while ensuring equitable access to digital infrastructure for all students. Course designers should incorporate synchronous collaborative elements—such as small-group discussions, peer feedback sessions, and language exchange modules—to strengthen social presence. Finally, policy-makers and administrators should recognize e-learning not

as a temporary alternative but as a strategic component of educational resilience, capable of expanding inclusion and innovation across higher education.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adhered in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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