University Students' Perspectives on Synchronous, Asynchronous, and Combined Virtual Learning Environments: Lessons Learned from the COVID-19 Pandemic

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ABSTRACT

Background: The COVID-19 pandemic significantly transformed higher education, shifting learning to digital platforms. This study explored university students' perceptions of synchronous, asynchronous, and combined virtual learning during this period.

Methods: This mixed-methods study involved surveying 361 students and conducting interviews with 15 individuals from September 2020 to July 2021 to explore undergraduate students' attitudes and perceptions of asynchronous, synchronous, and combined virtual learning. Quantitative data from questionnaires were analyzed using t-tests, while qualitative data from interviews were analyzed using an empirical phenomenological approach. The questionnaire was distributed during the second academic semester, while interviews were conducted at the end of the second semester.

Results: The findings revealed that students perceive combined communication as a more effective and high-quality method of learning compared to asynchronous and synchronous communication. The combined communication method was rated with a total mean of 3.58. In contrast, the asynchronous communication method was rated with a total mean of 3.02, and the synchronous communication method was rated with a total mean of 2.72. This could be attributed to the integration of traditional classroom learning with reflective techniques and the complementary use of both synchronous and asynchronous communication methods. Additionally, students have indicated that asynchronous communication is an effective means of compensating for missed synchronous classes and serves as a valuable backup in the event of technical issues. The combined communication also demonstrated advantages in time management, flexibility, and accelerated progress toward learning objectives. Furthermore, it helped maintain engagement by reducing repetitive content, boredom, and motivational slumps.

Conclusion: This research suggests that educators teaching online courses should adopt a multi-modal communication strategy to address the limitations of each approach. By employing a range of communication methods, professors can leverage the strengths of each approach while mitigating its weaknesses.

Keywords: Learning Experience, Distance, Education, Communication, Combined, Asynchronous, Synchronous

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Introduction

Technological innovations have significantly transformed conventional educational practices, particularly with the rise of virtual learning. The COVID-19 pandemic has accelerated this shift, integrating virtual learning into educational institutions worldwide. According to Hamutoglu and colleagues (1), Virtual Learning Environments (VLEs) are defined as online systems that facilitate interaction among students and educators, providing access to educational resources, leveraging advanced information and communication technologies. This mode of learning has become crucial for education, fostering collaboration and knowledge sharing without the limitations of time or location (2-4). Numerous studies have examined the effectiveness of communication within virtual learning frameworks, addressing both synchronous and asynchronous formats (5-10).

Virtual learning courses can be categorized into three types based on the nature of the educational interaction between instructors and learners: asynchronous, synchronous, and combined (10). Asynchronous virtual learning occurs at different times, meaning that students and teachers do not need to be present simultaneously (11-13). In this environment, students can access materials through various formats, including audio and video lectures, pamphlets, articles, and PowerPoint presentations. This content is available on demand via platforms such as Learning Management Systems (LMS) or alternative channels (14, 15), as well as collaborative learning environments like forums and discussion boards. Asynchronous virtual learning discussions are defined by Hew and Cheung (16) as text-based communication between humans via computer networks. The platform enables participants to interact and exchange ideas, insights, and personal experiences, thereby gaining multiple perspectives on any given topic and constructing new knowledge. However, the use of asynchronous technologies, a student-centred learning style

as proposed by Hrastinski and colleagues (17), and opportunities for delayed reactions, as suggested by Davidson-Shivers and colleagues (18), can facilitate the development of higher-level learning skills, such as critical thinking and deep learning, as outlined by Branon and Essex (13) and Huang and Hsiao (19). Pinto-Llorente and colleagues (20) found that students preferred autonomy in virtual asynchronous learning because it allowed them to customize their learning pace. This preference can be attributed to the inherent flexibility of this mode. In other words, asynchronous situations promote independent, student-centred, and self-paced learning (21). Virtual learning enables students to engage in learning activities independently, eliminating the need for synchronization in time or space due to the distance learning mode. This reduces shyness, embarrassment, and fear of the instructor, as supported in previous research (14, 22, 23). However, low participation and interaction are common issues with this mode of learning, as revealed in other studies (24, 25). Huang and Hsiao (19) pointed out that feedback delays are a significant weakness. Accordingly, asynchronous virtual learning is not immune to its own set of problems.

Conversely, synchronous virtual learning facilitates real-time interaction and collaboration among students and instructors, often incorporating E-tivities. E-tivities serve as frameworks for active and participative learning (26). This type of learning environment employs synchronous communication tools such as text chat, audio conferencing, video conferencing, and digital whiteboards (15). These tools are optional features of the course and represent a common application of technology in instruction, enabling multiple users to communicate through text messages (27). A synchronous virtual learning environment enables instructors and students to interact and collaborate in real-time (14, 28) as if they are in a face-to-face setting, despite the distance between them. This interaction occurs through the Internet, eliminating any geographic barriers.

The use of webcams and class discussion features is similar to a conventional classroom environment, except that all participants access them remotely via the internet. Synchronous sessions can increase motivation to participate in E-tivities due to the presence of educators and classmates (29). It is suggested that synchronous virtual learning provides greater social and cognitive presence than other forms of distance education (30, 31). Real-time interaction and high participation are identified as primary strengths of this communication by Salmon (26) and Giesbers and colleagues (24), respectively.

Wang and colleagues (32) found that students were dissatisfied with certain aspects of synchronous virtual learning, particularly technology-related issues such as communication delays and data insecurity. Technical difficulties, such as slow Internet speeds and network instability, may also cause frustration and setbacks for participants (26, 33, 34).

In the third approach, a combined virtual learning environment integrates synchronous sessions with an asynchronous set of E-tivities. The instructional design for both synchronous and asynchronous teaching may vary significantly (35). However, a lack of consensus remains regarding the optimal integration of these three communication methods within online courses (11, 15, 36, 37).

It seems crucial to differentiate between "combined virtual learning" and terms like "blended learning" or "hybrid virtual learning." While blended and hybrid learning can include both asynchronous and synchronous online components alongside face-to-face interactions (10), combined virtual learning strictly involves non-face-to-face interactions, relying solely on asynchronous and synchronous online engagement. This distinction highlights the unique characteristics of each educational approach in the context of modern digital learning environments. Based on the advantages and disadvantages of asynchronous and synchronous communication, researchers suggest that integrating both modes of communication in virtual learning can enhance learner motivation, engagement, and student learning outcomes (17, 25, 37-40).

The COVID-19 pandemic, which began in late 2019, led to a significant increase in demand for virtual learning, prompting Iranian universities to transition from in-person classroom instruction to online learning (41). A substantial portion of this virtual learning relied on asynchronous communication methods, primarily due to inadequate infrastructure for synchronous communication. This shift was highlighted by the urgent need for educational continuity amid widespread university closures and the challenges posed by the pandemic.

The University of *Bu-Ali Sina* developed the required infrastructure and implemented in-service training programs to enable professors and students to engage effectively in synchronous and asynchronous virtual learning during the COVID-19 pandemic. Consequently, it was crucial to explore how students develop their learning experiences and attitudes across various communication formats. This study aimed to investigate students' attitudes and experiences regarding virtual learning in synchronous, asynchronous, and combined formats, addressing seven specific Research Questions (RQs).

Quantitative and Qualitative Questions

RQ1: What is the virtual learning experience of students in asynchronous communication?
RQ2: What is the virtual learning experience of students in synchronous communication?
RQ3: What is the virtual learning experience of students in combined communication?
RQ4: Which mode of communication (asynchronous, synchronous, or combined) do students prefer for their future virtual learning period? (and why? for the qualitative phase)
RQ5: Which mode of communication (asynchronous, synchronous, or combined) do students consider to have the highest quality for their virtual learning course? (and why? For the qualitative phase)

RQ6: How do students perceive the correlation between asynchronous, synchronous, and combined virtual learning? (and why? For the qualitative phase)
Qualitative question
RQ7: What recommendations do students offer to enhance the efficacy of asynchronous, synchronous, and combined communication modes?

Methods

Study Design and Setting

This study employed a mixed-methods approach, consisting of two consecutive phases, from September 2020 to July 2021, at *Bu-Ali Sina* University, Hamadan, Iran. This approach involved two sequential phases: first, quantitative data collection and analysis, followed by qualitative data collection and analysis to further interpret the initial findings (42, 43). The study aimed to explore different aspects of VLEs and their impact on student experiences during the COVID-19 pandemic. Figure 1 illustrates the procedure of the study.

Participants and Sampling

The study's quantitative phase focused on undergraduate students at *Bu-Ali Sina* University, with a total population of 6,000 students. A sample of 360 students was randomly selected using the Krejcie-

Morgan table and Cochran's formula (44), employing stratified sampling proportional to different faculties. The selected participants had completed their previous two semesters through virtual learning and had experience with asynchronous, synchronous, and combined communication methods. Participants who failed to respond to more than 20% of the questions were excluded from the study.

Tools/Instruments

Quantitative phase: During the quantitative phase, researchers employed a survey to gather data on undergraduate students' attitudes and experiences regarding asynchronous, synchronous, and combined communication methods in VLEs.

The instrumentation consisted of a researcher-made questionnaire comprising 36 items, each using a 5-point Likert scale. This questionnaire assessed different aspects of VLEs, allowing participants to express their opinions and experiences effectively.

The questionnaire was adapted from several existing instruments, including those developed by Curtis and Keeves (45), Harris and James (46), Poon (47), Thien and Ong (48), and Schwarzenberg and colleagues (49). However, these instruments were not utilized in this study for various reasons.
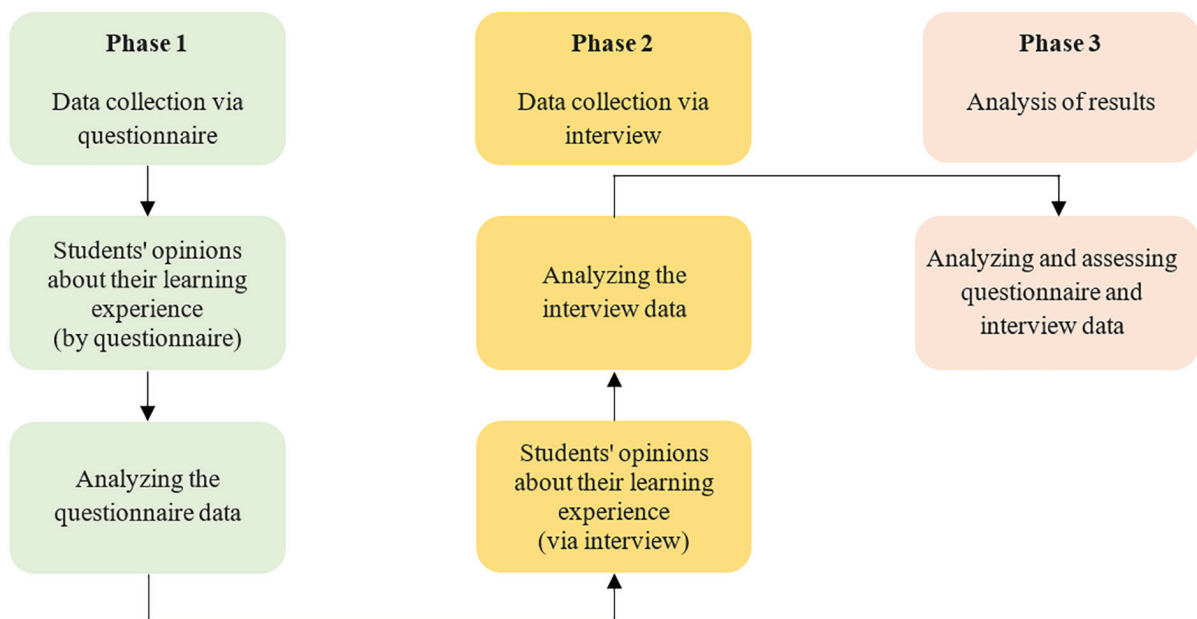

Figure 1: Process of the study based on students' experiences in virtual learning environments

Firstly, some of the questionnaires were not intended for student completion. Secondly, modifications were made to the items to align them with the specific research variables of asynchronous, synchronous, and combined learning formats. Lastly, particular components pertinent to the evaluation were not sufficiently supported by the original tools, according to the theoretical foundations of this study.

The final questionnaire consisted of four components designed to capture students' opinions on various types of VLEs. It featured 11 items focused on asynchronous virtual learning environments, 11 items addressing synchronous virtual learning, and another 11 items related to combined virtual learning formats. Additionally, three items were dedicated to comparing asynchronous, synchronous, and combined virtual learning, allowing for a comprehensive assessment of students' perceptions and experiences across these different educational modalities.

Qualitative Phase: Following the quantitative analysis phase, 15 semi-structured interviews were conducted to gather qualitative insights and validate the quantitative findings. The interviews were conducted using the descriptive phenomenological method, as outlined by Moustakas (50). Phenomenological research aims to thoroughly describe and understand phenomena as experienced by individuals in a specific situation (51, 52). Ethical guidelines and procedural standards were adhered to during the interviews, which involved students from diverse disciplinary backgrounds and academic semesters, ensuring a representative sample for robust research findings.

Validity and Reliability - The research questionnaire's content validity was assessed by four expert professors specializing in medical education and e-learning. The expert panel confirmed the content validity index for each item, ranging from 0.9 to 1.00. Reliability was evaluated using Cronbach's alpha, based on responses from 361 participants, yielding a reliability score of 0.77. This score indicates acceptable internal consistency of the questionnaire's questions (53). In the qualitative phase, to ensure the rigor and trustworthiness of the interview content, the open-ended items were reviewed and confirmed by the same four professors who evaluated the quantitative questionnaire. The extracted codes were subsequently returned to the interviewees for their approval.

Data Collection

During the quantitative phase, electronic questionnaires were developed, and the survey link was shared through students' social media networks and email, distributed proportionately across various academic disciplines.

In the qualitative phase, data were collected through semi-structured interviews that included all components of the quantitative questionnaire to cover the reasons behind the quantitative results. The interviews were conducted electronically via social networks such as Telegram and WhatsApp, utilizing both voice and text messaging formats. This synchronous interaction lasted between 45 and 100 minutes, allowing for dynamic communication between the interviewer and participants. Data collection was carried out in Persian.

Data Analysis

The normality of the data was evaluated using measures of skewness and kurtosis. Descriptive statistics and a one-sample t-test were employed to analyze the collected data. The qualitative data were categorized based on the main questions.

Results
Demographic Characteristics

A total of 361 undergraduate students participated in the survey. Among them, 17.45% were first-year students, 21.32% were second-year students, 30.76% were third-year students, and 30.47% were fourth-year students. Figure 2 depicts the participants' academic fields, while Table 1 provides a detailed breakdown of these areas.
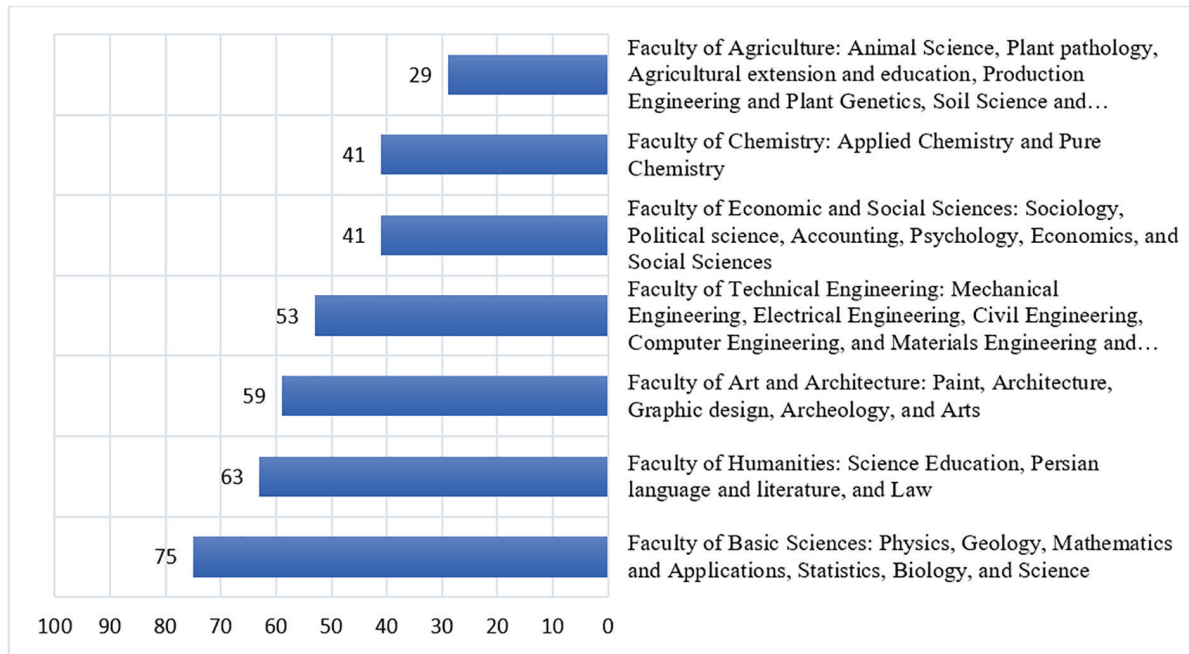
Figure 2: The participants' fields of study

Table 1: Year and field of study of undergraduate students interviewed

Faculties	ID	Characteristics
Engineering and Agriculture	No. 1	8th semester of Electrical Engineering
	No. 2	6th semester of Computer Engineering
	No. 3	8th semester of Agricultural Extension and Education
	No. 4	6th semester of Mechanical Engineering
	No. 5	4th semester of Agricultural Engineering
Basic Sciences, Chemistry, and Art and Architecture	No. 6	4th semester of Applied Chemistry
	No. 7	8th semester of physics
	No. 8	6th semester of Painting
	No. 9	6th semester of Architecture
	No. 10	8th semester of Archeology
Humanities and Social Sciences	No. 11	4th semester of Economics
	No. 12	8th semester of Law
	No. 13	8th semester of Educational Sciences
	No. 14	6th semester of Psychology
	No. 15	4th semester of Educational Sciences

Main Findings of the Quantitative Phase
Students' Attitudes toward Asynchronous Communication

Table 2 shows that all items are highly significant, with a significance value of $P<0.001$. Among the components evaluated by the students, asynchronous communication was found to help manage time and encourage self-paced, independent learning ($t=16.96$, effect size=0.89). Additionally, the students reported having sufficient time to comprehend the subjects ($t=10.44$, effect size=0.55),

indicating a high level of satisfaction. In contrast, the classroom processes and learning experiences were interactive, engaging, and motivating. The results showed a statistically significant difference with an effect size of -0.65 and $t=-12.34$. The professors' attendance was found to be at its lowest level ($t=-6.71$, effect size=-0.35).

Students' Attitudes toward Synchronous VLEs

Table 3 shows that all items in synchronous

communication are highly significant, with a significance value of P<0.001. Among these components, it was found that during synchronous communication, professors provided sufficient immediate feedback and comments on student work with an effect size of 0.70 and a t=13.37. In this study, it was found that professors were able to maintain high attendance rates (t=10.37, effect size=0.54). However, technical difficulties, particularly with internet connectivity, had a significant negative impact on the pace and progression of the class (t=-22.91, effect size=-1.2). Additionally, the allotted time for comprehension of course material was found to be insufficient (t=-10.27, effect size=-0.54).

Table 2: Students' attitudes toward asynchronous VLEs

Asynchronous VLEs items	Mean±SD	t	P value
In this communication, the professors devoted sufficient time to providing immediate feedback and commenting on my work.	2.77±1.06	-4.17	<0.001
In this communication, the learning process and class activities were collaborative, interactive, and motivating.	2.24±1.17	-12.34	<0.001
This communication helped me develop time management skills, as well as foster self-paced and independent learning.	4.00±1.12	16.96	<0.001
In the classes of this communication, the professors had a strict attendance policy.	2.56±1.24	-6.71	<0.001
In this communication, I usually had a clear idea of where I was going and what was expected of me in this course.	2.74±1.15	-4.36	<0.001
In this communication, we were generally given sufficient time to understand the subject matter.	3.57±1.04	10.44	<0.001
In this communication, technical problems, such as an affected Internet connection, impacted the flow and speed of the class.	3.39±1.49	4.99	<0.001
In this communication, the classes were mostly student-centered.	2.92±1.11	-1.32	0.18
This communication enhanced my advanced learning skills and profound understanding.	3.45±1.09	7.78	<0.001
To do well in this course, all I really needed was a good memory.	2.85±1.00	-2.89	<0.001
In this communication, the evaluation was more formative and occurred throughout the period.	2.76±1.10	-4.22	<0.001

Table 3: Students' attitudes toward synchronous VLEs

Synchronous VLEs items	Mean±SD	t	P value
In this communication, the professors devoted sufficient time to providing immediate feedback and commenting on my work.	3.67±0.96	13.37	<0.001
In this communication, the learning process and class activities were collaborative, interactive, and motivating.	3.34±1.08	6.05	<0.001
This communication helped me develop time management skills, as well as foster self-paced and independent learning.	2.49±1.17	-8.28	<0.001
In the classes of this communication, the professors had a strict attendance policy.	3.53±0.97	10.37	<0.001
In this communication, I usually had a clear idea of where I was going and what was expected of me in this course.	2.76±1.10	-4.11	<0.001
In this communication, we were generally given sufficient time to understand the subject matter.	2.33±1.23	-10.27	<0.001
In this communication, technical problems, such as an affected Internet connection, impacted the flow and speed of the class.	1.72±1.06	-22.91	<0.001
In this communication, the classes were mostly student-centered.	2.49±0.99	-9.66	<0.001
This communication enhanced my advanced learning skills and profound understanding.	2.44±1.24	-8.59	<0.001
To do well in this course, all I really needed was a good memory.	2.57±1.03	-7.84	<0.001
In this communication, the evaluation was more formative and occurred throughout the period.	2.66±1.06	-6.10	<0.001

Comparison of Asynchronous and Synchronous VLEs

After examining research questions 1 and 2, which focused on students' virtual learning experiences in asynchronous and synchronous communication contexts, it proved helpful to compare these two dynamics through thematic analysis (Table 4). This approach facilitated a deeper understanding and a broader perspective. Thematic analysis, as described by Clarke and Braun (54), is a qualitative method for identifying, analyzing, and interpreting recurring patterns or themes within data.

Students' Attitudes toward Combined VLEs

As shown in Table 5, each item has substantial significance as indicated by P<0.001. Among these components, students reported that professors provided sufficient time for immediate feedback and comments on their work in combined communication, with t=15.38 and an effect size of 0.81. Additionally, formative assessments were administered throughout the course, yielding an effect size of 0.78 and t=14.91. Students generally had sufficient time to comprehend the material, as indicated by an effect size of 0.74 and t=14.12. Students were generally

Table 4: Thematic analysis reflecting students' attitudes toward asynchronous and synchronous VLEs

Asynchronous	VS. Synchronous
Delay in providing feedback	Immediate and instant feedback
Non-interactive and non-participatory (passive and one-sided)	Interactive and participatory
Lack of serious attendance by professors	Serious and timely attendance of professors
Lack of students' engagement and class question and answer	Engaging students during class and asking questions
Lack of understanding of the content, uncertainty of the explanation, and incomplete explanation	Easy and clear understanding of the topics
Lack of understanding of the wishes, expectations, and intentions of professors	Understanding the wishes, expectations, and intentions of professors
Completely unspecified route and not achieving the goals of the first session	Completely specified route for the course and teaching
Lack of attention to whether or not studies	Paying attention to students' problems
Assessment in the form of an assignment and project	Assessment based on attendance, absences, class questions and answers, participation in discussions, homework, activities, exercises, presentations, and conferences, with the lowest score assigned at the end of the semester and mid-term.
Sufficient accuracy and patience in reviewing assignments and providing feedback	Incomplete feedback
Suitable for busy students	A problem for busy people
Commitment, accuracy, and order in the production and uploading of tasks and files	Problem uploading the exam
No technical problems	Problem in not having high-speed internet access in rural and border areas, continuous disconnection and connection of classes, and canceling and postponing classes to another hour.
Having a good time submitting and uploading files	Short exam time against difficult questions
Increasing the depth of learning	Superficial learning
Presenting lesson plans	Presenting the lesson plan and acting on it
The class process is neither one-sided nor multi-sided	The class process is neither one-sided nor multi-sided

Table 5: Students' attitudes toward combined VLEs

Combined VLEs items	Mean±SD	t	P value
In this communication, the professors devoted sufficient time to providing immediate feedback and commenting on my work.	3.83±1.03	15.38	<0.001
In this communication, the learning process and class activities were collaborative, interactive, and motivating.	3.49±1.01	9.21	<0.001
This communication helped me develop time management skills, as well as foster self-paced and independent learning.	3.63±0.97	12.42	<0.001
In the classes of this communication, the professors had a strict attendance policy.	3.62±0.98	11.98	<0.001
In this communication, I usually had a clear idea of where I was going and what was expected of me in this course.	3.80±1.10	13.92	<0.001
In this communication, we were generally given sufficient time to understand the subject matter.	3.90±1.21	14.12	<0.001
In this communication, technical problems, such as an affected Internet connection, impacted the flow and speed of the class.	2.79±1.09	-3.63	<0.001
In this communication, the classes were mostly student-centered.	3.48±0.97	9.34	<0.001
This communication enhanced my advanced learning skills and profound understanding.	3.71±1.13	11.91	<0.001
To do well in this course, all I really needed was a good memory.	3.36±1.26	5.42	<0.001
In this communication, the evaluation was more formative and occurred throughout the period.	3.80±1.02	14.91	<0.001

given sufficient time to understand the subject matter, as evidenced by an effect size of 0.73 and t=13.92. In addition, the course provided time management skills and promoted self-directed, independent learning, with an effect size of 0.65 and t=12.42. The professors maintained a high level of attendance, as evidenced by an effect size of 0.63 and t=11.98. The course significantly improved students' high-level and deep learning skills, as evidenced by an effect size of 0.63 and t=11.91. Technical problems, such as the Internet connection, affected the flow and speed of the class, as indicated by t=-3.63 and an effect size of -0.19 at the lowest level.

Students' preferences for future VLEs

According to the results of the quantitative questionnaire, 77.83% of the students opted for combined communication, while 12.46% and 9.69% chose asynchronous and synchronous communication, respectively, for their upcoming learning course.

In the qualitative findings, only one out of 15 students (No. 3) preferred asynchronous communication for their future course due to its time flexibility, the ability to reflect more on topics, and its project-

oriented nature. Meanwhile, three students (Numbers 1, 4, and 9) selected synchronous communication because it offers increased participation, immediate feedback, emotional communication, motivation, detailed course description, and opportunities for discussion. Eleven out of 15 students (Numbers 2, 5, 6, 7, 8, 10, 11, 12, 13, 14, and 15) preferred combined communication for their upcoming learning course because it provides various benefits. The ability to catch up by following asynchronous communication, supplemented by synchronous learning, is crucial for achieving learning goals. Reviewing media, addressing problems and questions, achieving goals efficiently, and enjoying flexible homework options are key advantages. While technical challenges can hinder synchronous communication, asynchronous communication can be helpful in these cases.

Student No. 15 explained:

"…I prefer combined classes because some online classes suffer from low student participation, and synchronous classes can become repetitive and dull due to their repeated sessions. My approach to combined classes has been successful in most cases...."

Students' Perspectives toward the Quality of VLEs

According to responses about past virtual learning experiences, 74.51% of students rated combined communication as higher quality. Asynchronous communication was preferred by 17.17% of students, while only 9.41% favored synchronous communication.

In the qualitative findings, only one student (No. 3) out of 15 found asynchronous communication to be of higher quality for their learning experience, as it allowed them to review the content. Three students (Numbers 1, 4, and 9) favored synchronous communication for its advantages, including the ability to ask questions and receive immediate feedback, as well as direct real-time interaction with professors. The majority of students—11 out of 15 (Numbers 2, 5, 6, 7, 8, 10, 11, 12, 13, 14, and 15)—found a combination of synchronous and asynchronous communication most effective. They found it beneficial when transitioning from asynchronous to synchronous communication, which resembled face-to-face teaching while enabling reflective learning and leveraging the strengths of both formats. This combined approach also provided a sense of an actual classroom environment, improved time management, and offered peace of mind.

Student No. 13 explained:

"…Combined is of higher quality. In combined learning, students can experience a real classroom setting, especially when they participate actively. However, in synchronous learning, technical or hardware issues can hinder the flow of information and access to the class and the professor. Therefore, in addition to this communication, we also utilize asynchronous learning, which enables students to engage and solve problems.…"

Relationship between Asynchronous, Synchronous, and Combined VLEs

Around 66.75% of students affirmed that combining asynchronous and synchronous learning environments was effective, as they complemented each other well. Meanwhile, 17.72% stated that the two environments were somewhat related, 9.69% indicated that the connection between them was occasionally unclear, and 5.81% believed that there was no correlation between the two environments.

Qualitative data revealed that 13 out of 15 students (numbers 2, 3, and 5-15) believed integrating both learning styles was advantageous and mutually reinforcing. Two students (numbers 1 and 4) acknowledged a partial connection between them, but none identified a strong correlation. Thirteen students explained their preference for combining both methods, citing reasons such as improving understanding by studying part of the content synchronously and reinforcing it asynchronously, leveraging the strengths of both approaches, overcoming limitations by integrating them, enhancing asynchronous learning through interactive synchronous sessions with teachers, avoiding monotony, and saving time.

Student No. 12 explained:

"…The asynchronous and synchronous learning environments complement each other, making their combination ideal. Each has its strengths and weaknesses, and sometimes circumstances necessitate choosing one over the other. However, I believe that integrating both creates a better platform for effective time management and communication…"

Students' Recommendations to Enhance the Efficacy of VLEs

The students' suggestions were analyzed and divided into four categories: common suggestions for three types of communication, suggestions for asynchronous communication, suggestions for synchronous communication, and suggestions for combined communication (Table 6).

Table 6 presents the students' suggestions for improving and enhancing the effectiveness of all three types of communication, considering their strengths and weaknesses. Asynchronous communication was recommended as a means to facilitate better collaboration, resulting in more robust content and activities.

Table 6: Students' recommendations for improvement and effectiveness of VLEs

Recommendations
Typical recommendations for all three VLEs
Creating effective design; clarify the reasons for implementing the program to the learner (13). Ensure the necessary infrastructure is provided (3, 14). Providing essential training for professors and learners, presenting challenges for the learner's mind, and establishing a suitable space for students to seek answers to their questions (14). Enhancing the quality of educational facilities and improving Internet connectivity (2, 4, 5, 7, and 15). Utilizing appropriate teaching methods for practical lessons (3). Standardizing questions to fit student schedules (3).
Recommendations for asynchronous VLEs
Serve as a communicator; teachers should adopt a guiding role (13). Improving activities (15). Develop engaging content (12). Fostering communication between faculty and students (10). The content should match students' capacity and ability (8). Providing additional images and videos (2).
Recommendations for synchronous VLEs
Access to all necessary facilities and leniency regarding class attendance (14). The course should not be delivered entirely in a synchronous format, as prolonged sessions can strain students' hearing and vision, potentially leading to boredom (15). Incorporating more visual communication is recommended (6, 12). Monitoring class scheduling by education officials (11). Increasing both the number and duration of classes, as well as extending the frequency and scheduling of class sessions (10). Conducting stress-free sessions to clarify questions and address ambiguities (1, 6, 9, and 10). Complete the content delivery (8). Create a friendly classroom atmosphere (9). Schedule classes at convenient times (2). Encourage student participation in both teaching and reviewing assignments (13).
Recommendations for combined VLEs
Utilize this type of communication as much as possible to conduct courses (5, 6, 12, 13, and 15). Explore different programs (6, 9, and 13). Incorporate open-book questions for exams and in-class questions (13). Create more challenges (13). 40% of the class should be synchronous and 60% asynchronous, with 60 minutes synchronous and 30 minutes asynchronous in a 90-minute class (15).

The numbers (1 to 15) correspond to those assigned to the interview participants, provided here to illustrate objective examples.

The students suggested that the course should not be entirely synchronous and that classes should be more collaborative, with increased opportunities for live communication to facilitate questions, answers, and clarification of ambiguities. They recommend utilizing this form of communication as much as possible for combined learning, with 40% of the course delivered synchronously and 60% asynchronously.

Discussion

This study examined the virtual learning experiences of Iranian college students in asynchronous, synchronous, and combined modes. The research utilized a survey and interviews to collect data on students' attitudes and experiences. The questions focused on these attitudes and experiences across the three communication modes. The literature does not clearly indicate which communication approach is more effective for students. Data gathered through both quantitative and qualitative methods suggests that most participants did not prefer either asynchronous or synchronous communication for various reasons. However, they found that combined communication was effective for their learning and preferred it over the other two forms. This finding aligns with prior studies (9, 12, 25, 38, 40, 55, 56).

Experiences in asynchronous communication: The results of the students' virtual learning experience in *asynchronous communication* revealed that, despite having autonomy and sufficient time to comprehend the subject matter, they remained uncertain and grappled with unanswered questions. This hinders their ability to engage with the materials fully and leads to the postponement of activities and work. In addition, although feedback was delayed and the class process was non-interactive and non-participatory (57), feedback on assignments was provided

with sufficient accuracy and patience, reducing dependence on professors, and there were no technical problems (11, 58).

The results of our study support the claims of Branon and Essex (13) and Huang and Hsiao (19) that asynchronous communication enables students to utilize advanced learning skills, such as critical and divergent thinking, due to the extended time spent thinking about problems. In this format, instructors acted as mentors, and access to additional resources was available simultaneously. The findings support the contention of Villanueva and colleagues (25) and Murphy and colleagues (21) that asynchronous communication facilitates independent and self-paced learning by accommodating students' learning paces, providing flexibility, and creating a more personalized learning environment. Anticipating a variety of instructional formats is crucial for effective asynchronous learning strategies. Presenting a text-only course may discourage learners who prefer to learn concepts through visual aids, such as film or electronic simulations. Failure to engage self-directed learners may cause them to disengage from the course. Our study supports the conclusions of Pinto-Llorente and colleagues (20) that asynchronous virtual learning offers students greater autonomy compared to synchronous communication. In the asynchronous format, busy students can complete their assignments and activities independently.

The research findings, consistent with Huang and Hsiao's study (19), suggest that asynchronous communication results in delays in the delivery of feedback by professors. This is due to students' reported difficulties in understanding the content and the lack of opportunities to ask questions and clarify uncertainties. Students identified several factors that contributed to their dissatisfaction with the course. These factors included a lack of variety, unclear and incomplete explanations, an excessive amount of material, insufficient feedback from professors, and insufficient opportunities to express their opinions. Additionally, they found the course

structure unclear and struggled to understand the instructors' expectations and intentions. According to the findings, students have reported a decrease in participation and interaction, which is consistent with the results of previous studies (24, 25).

Experiences in synchronous communication: In *synchronous communication*, feedback from professors is timely and promotes interactive and collaborative learning (28, 12). However, both quantitative and qualitative data suggest that it remains incomplete. Students may not have enough time to comprehend topics, especially when technical issues such as Internet connectivity can negatively impact the pace and flow of the class (11, 12, 57).

Synchronous learning courses follow a set schedule, whereas asynchronous learning courses do not. It is essential to prioritize program flexibility and record online events for those who are unable to attend at the scheduled time. Before the course begins, a survey should be conducted to find out the days and times that are most convenient for the majority of learners. This ensures that individuals can get the information they need, regardless of unforeseen obstacles. Our findings support Yamagata-Lynch's (29) claim that synchronous communication increases students' motivation to stay engaged in E-tivities. This is because teachers and classmates are physically present, much like in a face-to-face class, allowing for interaction, participation, and immediate feedback. In synchronous communication, the evaluation process focuses on class participation through discussions, question-and-answer sessions, homework assignments, activities, presentations, and conferences, as well as regular attendance and absence records. The lowest grades were assigned to the midterm and final exams.

Our research on synchronous communication and social presence is consistent with other studies (30, 31). Synchronous communication allows for live interactions between professors and peers, facilitating the exchange of genuine emotions

and feelings. Based on student feedback, the professors were consistently punctual and effectively engaged students, whether they were present or absent. The instructor demonstrated skilful time management during class, selected appropriate content, and used illustrative images. Additionally, they reviewed topics, asked insightful questions, addressed student concerns, and employed a range of teaching methods.

The research confirms Branon and Essex's (13) assertion that due to time constraints in the classroom, students have limited opportunities to reflect on and engage in mature discussions about synchronous communication. It is impossible to cover all topics with the interaction and participation of each student, which inevitably limits the quality of discussion. These findings are consistent with research from several studies (25, 32-34), which have demonstrated technical issues with synchronous communication in Iran due to poor Internet connections and limited access to high-speed Internet.

Furthermore, the quantitative data from our study support the findings of Murphy and colleagues (21), indicating that synchronous communication is indeed informative. However, our qualitative results contradict this assertion. Students reported that they engaged, participated, and received timely feedback in these classes. This dichotomy may stem from variations in professors' knowledge and experience. Students who interacted with a highly knowledgeable and experienced professor may provide different feedback compared to those who interacted with a novice professor.

Experiences in combined communication: The students provided constructive feedback on *the combined communication*, based on both quantitative and qualitative data. However, technical difficulties associated with the hardware and software were also observed in other areas. The findings provide support for using combined communication approaches to enhance students' learning experiences. In particular, the claims and conclusions outlined in prior research (9,

12, 25, 37-40, 55, 56) are supported. The combination of both modalities allows for the strengths of one mode to offset the weaknesses of the other, thereby creating a more authentic classroom experience that fosters reflective learning. This approach also increases flexibility and accelerates goal achievement. In combined communication, students were informed that the evaluation would be based on a combination of mid-semester and end-of-semester exams, class attendance, various activities, presentations, conferences, assignments, and projects, with a formative approach. It is important to note that combined learning heavily relies on technology. As such, both faculty and students require access to the necessary educational tools.

Students' preference: The majority of higher education students express a preference for combined learning courses, as evidenced by both quantitative and qualitative data (9, 38-40, 55). These courses utilize both asynchronous and synchronous communication in a way that effectively overcomes the inherent limitations of each mode. For instance, if students are unable to attend the live class or face technical difficulties, they can catch up on their coursework through asynchronous communication. It is crucial to emphasize that this option should only be used when strictly necessary and not as a substitute for attending live classes.

The quantitative and qualitative data indicate that the majority of students perceive synchronous and asynchronous learning environments as complementary, leading to improved communication quality within their courses. Respondents asserted that asynchronous communication offers a solution to any issues encountered with synchronous communication. Furthermore, they observed that the combined communication approach facilitates more effective time management, promoting a sense of tranquility.

The majority of students appear to benefit from a combination of asynchronous and synchronous learning environments,

as evidenced by both quantitative and qualitative data (9, 38-40, 55). Accordingly, the combined use of synchronous and asynchronous communication tools has the potential to enhance learning outcomes and prevent boredom, monotony, and decreased motivation.

Limitations and Suggestions

The findings highlight the significance of assessing students' learning experiences in virtual environments. However, this study faced certain limitations. First, while we examine various variables, there are additional factors—such as scaffolding, social presence, motivation, engagement, instructional design, and self-regulation—that warrant further investigation in future research. Second, the interview data were translated from Persian to English by the first author, who was actively involved in the data collection process. The interviews were conducted using voice and text messages in a virtual format. To enhance effective communication and ensure mutual understanding between the interviewer and interviewee, it is advisable to conduct interviews in person or through synchronous video conferencing. Finally, the study did not account for the level of experience of the teaching professors, which could influence student feedback.

Conclusion

The findings of this study have significant implications for advancing and implementing virtual courses, particularly in the Iranian context. The results indicate that undergraduate students can benefit from effective and sustainable learning experiences through a combination of asynchronous and synchronous communication methods. However, each approach has its distinct advantages and disadvantages. It seems crucial for Iranian policymakers and academics to acknowledge and leverage the strengths and limitations of asynchronous communication to enhance the efficacy and output of their courses. Our findings indicate that although feedback from professors in asynchronous

communication is accurate and patient, it is often accompanied by delays that can lead to students disengaging from discussions and becoming frustrated. Synchronous communication provides immediate and instantaneous feedback. However, this approach may be insufficient, impeding students' comprehensive understanding of the subject matter. Conversely, a combined approach provides active and continuous feedback accompanied by comprehensive guidance. This leads to a course with optimal and effective feedback. Therefore, professors are encouraged to use a combination of virtual learning and various programs to address the limitations of a single mode of communication. This will help resolve any shortcomings.

Abbreviations

VLEs: Virtual Learning Environments
LMS: Learning Management Systems

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Authors' Contribution

RB designed and conceptualized the study, collected and analyzed the data, and drafted the manuscript. ZH contributed to the methodology and revised the article. Both authors reviewed and approved the final version of the manuscript.

Conflict of Interest

The authors declare that there are no conflicts of interest.

Ethical Considerations

The research was conducted in accordance with ethical standards, and participants provided informed consent after being thoroughly briefed on the study's objectives and confidentiality measures. They were assured that their data would remain

confidential, following the principles of research ethics and data protection. The corresponding author acknowledges the institutional affiliation with *MehrAlborz* University, Tehran, Iran, as verified by certificate No. 116/1403, issued on March 13, 2024.

Availability of data and materials

The data used and analyzed in the current study are available from the authors upon reasonable request.

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