Asian Journal of Distance Education

Asynchronous Interaction in An Online Course: Examining Dynamics from the Action Research Perspective

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Abstract: This action research aims to investigate the determinants of asynchronous interaction among students, interaction between students and instructors, and interaction with course content in an online learning environment. The study involves fifteen graduate students from a state university as participants. The research employed multiple data collection instruments, including commission meeting reports, focus-group sessions, semi-structured interviews, observation forms, emails, video recordings, researchers' diaries, and system log records. The content analysis method was employed for data analysis. The findings revealed that in learner-learner interaction, instructional method, notifications, technical issues, and individual problems exert discernible effects. For learner-instructor interaction, feedback, instructional methods, and the utilization of diverse communication channels were identified as influential factors. Moreover, technical problems, time constraints, and system usability emerged as key elements shaping learner-content interaction. Notably, learners' personal preferences, encompassing attitudes toward the online course and time management, manifested both positive and negative effects across all interaction types. The study has concluded that assignments with open access, star-based scoring, and mobile notifications enhance learner-learner interaction. Instant feedback from instructors and notifications initiated by instructors enhances learner-instructor interaction. Overall, optimal system usability and minimal technical issues contribute substantively to augmenting learner-content interaction.

Keywords: asynchronous interaction, learner-learner interaction, learner-instructor interaction, learner-content interaction, distance education

Highlights

What is already known about this topic:
- In the existing literature, it is noted that asynchronous interactions often result in limited and brief discussion periods. However, research in this area is scarce.
- Additionally, it has been stated that material usage, group size, and information density can influence asynchronous interaction.

What this paper contributes:
- In this study, factors influencing asynchronous interaction have been examined through action research.
- Providing assignments with open access tasks to everyone, sending mobile application notifications, rating with stars, and commenting on tasks have been shown to enhance asynchronous interaction.

Implications for theory, practice and/or policy:
- The instructional method, notifications, technical issues, and individual factors have been noted to affect student-student interaction.
- Moreover, feedback, instructional methods, and communication channels influence student-teacher interaction, while technical issues, time constraints, and system usability impact student-content interaction.

Introduction

Distance education is an education model in which technological facilities such as computer, video and audio are used and two-way communication is provided to bring together students and teachers in different environments and to carry the course content (Keegan, 1996). Bates (2005) characterizes distance education as an instructional paradigm that employs technological instruments to establish bidirectional communication, thereby converging students and educators in disparate locales for the conveyance of curricular material. Distance education has many advantages such as time and place independence, lifelong learning, and being able to provide education to large audiences easily. Distance education has become almost the only way for millions of students to continue their education, especially during the COVID-19 epidemic that has affected the whole world (Lall & Singh, 2020; Sun, Tang & Zuo, 2020).

Distance education has numerous advantages, including enhanced accessibility, flexibility, and cost-effectiveness, facilitated by evolving technologies (Cavus & Ibrahim, 2008; Tallent-Runnels et al., 2006). Nevertheless, distance education also entails certain limitations. Among these limitations, the most emphasized is the lower level of interaction provided by the distance education environment compared to face-to-face instruction (Bernard et al., 2009; Salta et al., 2022). One of the fundamental distinctions widely acknowledged between conventional face-to-face education and distance education lies in the level of interactive engagement (Valentine, 2002). When scrutinizing the evolution of distance education, numerous theories prominently center around the pivotal concept of interaction. Interactional Distance Theory introduced by Moore's (1993) Interaction Equivalence Theory are some examples of theories developed to study communication and interaction in various contexts. In addition, Baath, Holmberg, and Daniel have conducted numerous studies on communication and interaction in distance education (Gokmen et al., 2016). In the Communication and Interaction theory, it is stated that it is possible to provide two-way communication with exercises, questions or control tests in the materials prepared for education. Moore (1993) argues that the variables of structure, dialogue and learner autonomy must be taken into account in the design of an online course. Another theory about interaction is Anderson's theory of interaction equivalence. According to this theory, interaction is needed in order to be able to communicate verbally or non-verbally, and interaction in education provides a quality learning and enables students to communicate with each other or with their teacher (Anderson, 2003).

In the literature, interaction types in distance education are generally divided into three categories: learner-teacher, learner-learner and learner-content (Anderson, 2003; Ling, 2007; Hark Söylemez, 2023). Insufficient level of interaction in any of these negatively affects the success of distance education (Ji et al., 2016; Hawkins et al., 2012; Hawkins et al., 2013).

Interaction in distance education environments is handled in two dimensions as synchronous and asynchronous. It is known that asynchronous interaction is as important as synchronous interaction in distance education (Vonderwell, 2003; Amiti, 2020). However, especially in the context of COVID-19, it has been observed that synchronous sessions, which allow for easier transfer of in-person teaching practices, are preferred more often (Karatepe et al., 2020). As a result, applications that prioritize asynchronous activities have taken a back seat. However, it is necessary to design synchronous and asynchronous activities together, which are the two main components of distance education. Therefore, there is a need for research focused on increasing interaction with asynchronous activities.

Increasing asynchronous interaction depends on various factors such as the proper use of different teaching techniques (question-answer, problem-solving, brainstorming etc.) (Vonderwell, 2003), a wide range of educational materials (Guo et al., 2014) and feedback in online courses (Smith & Winking Diaz, 2004; Levin, Waddoups & Buell, 2001). First of all, online discussion/forum environments can contribute to higher levels of asynchronous interaction, especially when proper teaching techniques such as asking critical thinking questions were used (Schindler & Burkholder, 2014). However, the duration of activities as well as discussion environments, material usage, group size, information density and formal language usage can affect asynchronous interaction (Hew & Cheung, 2011; Patriarcheas & Xenos, 2009).

As for the use of different materials, although the literature shows that use of various materials can increase asynchronous interaction, it should be emphasized that unnecessary use of these elements can negatively affect interaction (Darabi & Jin, 2013). Finally, feedback plays a critical role in increasing asynchronous interaction in online courses due to studies showing that timely and constructive feedback can increase learner participation and motivation (Smith & Winking Diaz, 2004).

On the other hand, Farros et al. (2020) state that the current studies in the literature do not provide sufficient evidence for the effects of discussions in an asynchronous environment. For this reason, it can be said that there is a need for research studies conducted in different contexts in order to reveal the strategies to be used to increase asynchronous interaction (Agudo-Peregrina et al. 2014; Zhang et al., 2018). In addition, although studies have gained more and more importance in the dimension of interaction in distance education, it is still not at the desired level (Conde-González & Hernández-García, 2014; Al-Musharraf & Alkhattabi, 2016; Zhang et al.,2018; Rodrigues et al., 2016).

Quantitative studies on this topic may be found in the literature (Hawkins et al.,2013; Zhang et al.,2018) as well as individual case studies (Beese,2014; Ingerham,2012; Johnson, 2008). However, there is a lack of an action research study. Out of the 80 articles indexed by SSCI and ULAKBIM databases, as well as the action research articles that were classified into 12 different categories, only three were found to have been conducted. Indicating a significant limitation in research within this field. In this study, an action research was conducted to identify issues related to interaction and to generate practical solutions by participating in the online course process. In this context, a systematic analysis was also performed. It is thought that the selected action research method is likely to make important contributions to the literature. Action research is a recognized and accepted approach in the field of education (Rearick & Feldman, 1999; Hansson, 2003). Involving the stakeholders in the research process (Karasar, 1999), developing applications in the process and repeating the process by evaluating the results regularly (Calhoun, 2002) distinguish action research from other researches. Based on all these, this study aims to investigate how to increase student-student, student-teacher and student-content interaction in an asynchronous environment. For this purpose, answers to the following research questions were sought:

1. How to increase student-student interaction in asynchronous environments?
2. How to increase student-teacher interaction in asynchronous environments?
3. How to increase student-content interaction in asynchronous environments?

Methodology

This paragraph discusses the prevalence of quantitative research and the limited number of articles on distance education in the field of asynchronous interactions. Relevant studies by authors such as Hawkins (2018), Zhang (2018), Beese (2014), Ingerham (2012), Johnson (2008), and Çalışkan and Serce (2018) are cited as sources of information. Action research differs from other research methods in terms of participants being involved in the research process (Karasar, 1999), applications developed in the process and evaluation of results on a regular basis (Calhoun, 2002).

Action research is a systematic research process in which the person/people working in the educational institution where the problem is experienced are researchers and the answer to the 'how' question is sought in research questions (Mills, 2003). Along with different definitions of action research, different types of classifications also exist in the literature. According to Holter and Schwartz-Barcott (1993), the 'mutual collaboration' type of action research is also known as practical action research. It is used to identify problems, possible factors that cause these problems, and possible interventions to solve them. In this study, this method is chosen since the question of how to increase asynchronous interaction in an online course is investigated.

Participants

The participants of the study consisted of fifteen students pursuing their master's degree in educational sciences at a state university during the 2018-2019 academic year. Participation in the study was voluntary. At the beginning of the study, the participants were informed about the nature of the study as well as confidentiality and privacy issues. In order to protect participants' privacy, each participant was given a pseudonym (i.e. P1, P2). There were eight male and seven female participants. While 11 students identified themselves as android users, the rest indicated that they were IOS users.

In this study, action research, one of the qualitative research methods, was used. Convenience sampling from the non-random sampling category was used. The sample of the study, on the other hand, consists of 15 students studying within the scope of a course conducted at the master's level with distance education at Atatürk University.

Context

The data was collected from a course that spanned ten weeks, with each session lasting three hours. This course was offered in both online and face-to-face formats, allowing students to attend according to their preference. A weekly average participation in the course was five students for the face-to-face environment and ten for the online environment. As indicated in Figure 1 (Ustun et al.,2024), the Hyflex learning model has been chosen. The Hyflex learning model presents an attractive alternative for students who are enrolled in face-to-face education but are also obligated to fulfill other responsibilities. This model's flexibility allows students to participate in classes according to their own preferences. The students' participation in the course changed every week in the direction of their own preferences. The students who were physically in the classroom were asked to bring either their computers or smart phones with them to the classroom. They connected to the online course through their devices so that they could communicate with the other students.

Students disseminated their assignments via a publicly accessible forum site, bote.site. This platform afforded students the opportunity to scrutinize and evaluate each other's assignments. Students engaged in various interactions, including commenting and star-rating each other's assignments. These interactions fostered knowledge sharing and collaboration among students. To augment asynchronous interactions, mobile notifications were dispatched to students. These notifications assisted students in keeping abreast of course-related updates and maintaining their interactions.

Figure 1. The learning model used in the research and its position compared to other models.
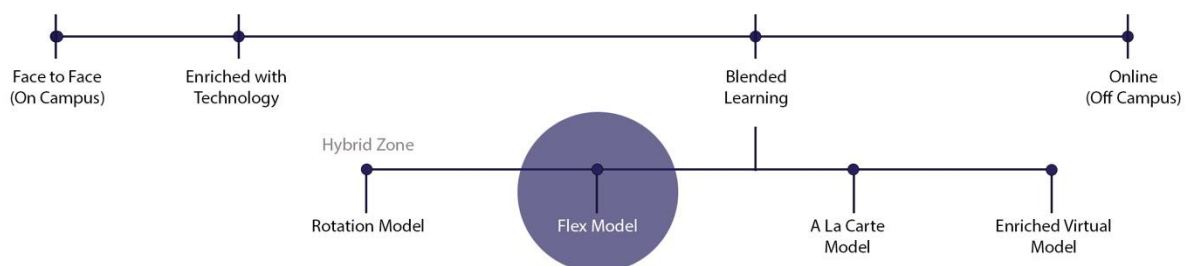
Data Collection Tools

The data collection tools were divided into three categories; experience-based tools, inquiry-based tools, and investigation-based tools (Figure 2).

Figure 2. Data collection tools

Experience-based tools

The experience-based tools consist of commission meeting reports, researchers' diaries, and observation forms. According to Coats (2005), the action research process consists of four stages as a loop; plan, action, observation, and reflection. In this direction, the academic staff and the researchers held commission meetings in order to make decisions about the implementation and to determine action plans. However, it is critical to follow up the impact of the determined actions, the difficulties encountered during the implementation, and the situations that prevent application of the decisions (Kemmis et al., 2004). For this purpose, an observation form, developed by the researchers and updated in line with expert opinions, was completed on a weekly basis. In addition, the researchers kept diaries regularly regarding the students' interactions in the asynchronous environment and reflections on these actions. The observation forms, researchers' diaries, and online course records were used to make decisions in the commission meetings, which were also used as data sources.

Inquiry-based tools

The inquiry-based tools consisted of focus group interviews conducted throughout the research process and semi-structured interviews conducted at the end of the process. In the focus group interviews, the participants were asked about the web page and the mobile application that had been designed for the online course. During the interviews, the participants shared their thoughts about their ASYNCI and the efforts to increase this interaction. Both interview forms were developed by the researchers and revised by two experts in the field.

Investigation-based tools

The investigation-based tools consisted of weekly-collected e-mails, online course records, and logs. Throughout the implementation, e-mails were used by the instructor and students in order to discuss the technical issues and their solutions, with these e-mails being considered as a data source in the study. In addition, video recordings of the online courses taught on Adobe Connect were used for weekly

evaluations at the commission meetings. Moreover, in order to determine the effects of applications that were designed to increase the level of ASYNCI, the logs obtained through Firebase, OneSignal, and Google Analytics were considered as another data source.

Research Procedures

The action research process aiming to increase the level of ASYNCI started on 4 October, 2018. It lasted for ten weeks and ended on 16 December, 2018. The procedures performed each week are summarized in Figure 3.

Figure 3. Weekly procedures in the study
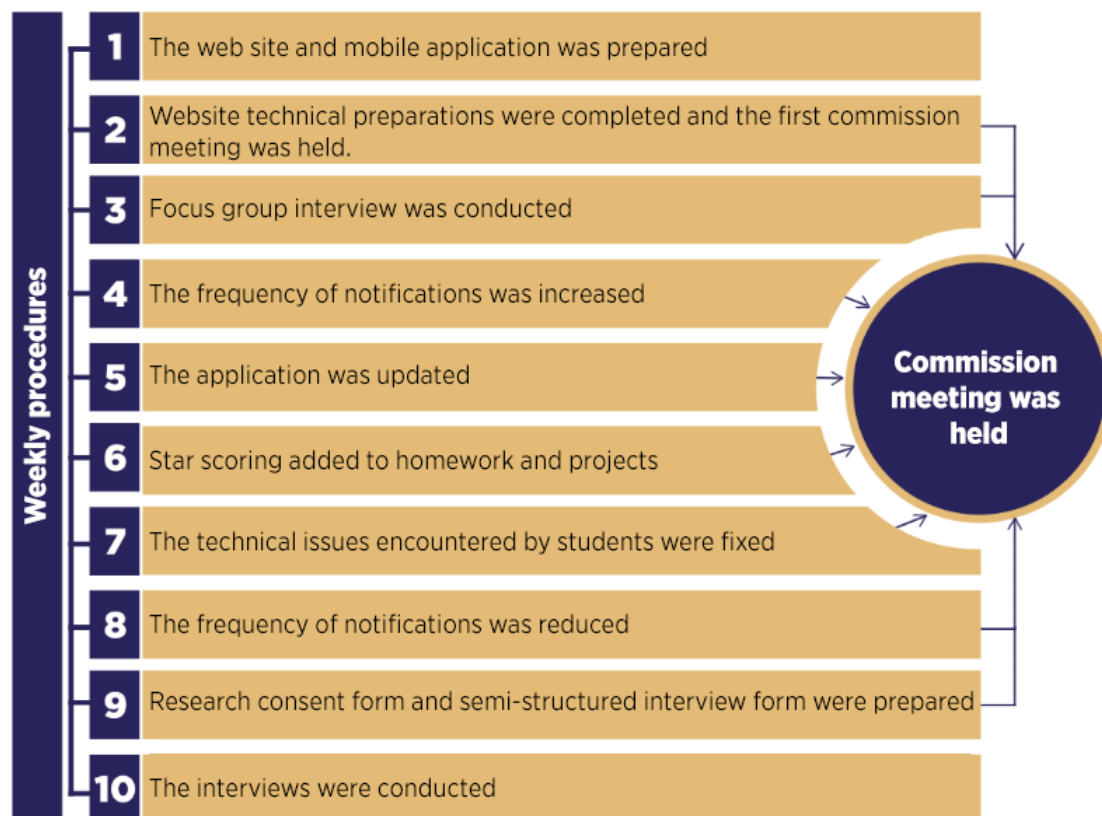
As can be seen in Figure 3, the first two weeks were devoted to technical work related to the web site, the mobile app, and the system. Focus group meetings were held from week three to week nine. At the same time, necessary revisions were made to increase ASYNCI with the action plans that were identified in the commission meetings based on weekly observations, log records, and researchers' diaries. In week nine, a semi-structured interview form was developed and a number of interviews were conducted. In week ten, the interviews were completed and the action research was finalized. Details of the steps carried out during the research process are presented in the weekly format in ANNEX-1.

### Applications Developed in the Research Process

Throughout the research, a website and a mobile application were designed. Since both of these ran on the same database, all of the updates were made synchronously. In the mobile app development process, the WebView feature was added, ensuring that it worked stably on Android systems. The web site had features including creating membership, commenting, sharing homework, scoring with stars, viewing announcements, and viewing the syllabus of the course. The fact that the mobile application worked only on devices with the Android operating system caused students who preferred the IOS operating system not to receive notifications. In order to eliminate this deficiency, it was decided to add

a browser notification feature to the website in the commission meeting. As a result, all of the students were able to log in to the web site and receive all notifications.

The instructor was able to send notifications to the students using the website, and the students were able to both upload their homework and comment on the assignments of the others by logging in to the web site. More specifically, when the instructor posted notifications, all of the students were informed. In addition, when the students commented on assignments, a notification was sent to the owner of the assignment. Through this feature, the researchers aimed to increase the learner-learner and learner-instructor interactions. While Google's FireBase platform was used to send out mobile application notifications, the OneSignal platform was used to send out browser notifications. The applications developed during the research process and their features are presented in Figure 4.

Figure 4. Applications and their features
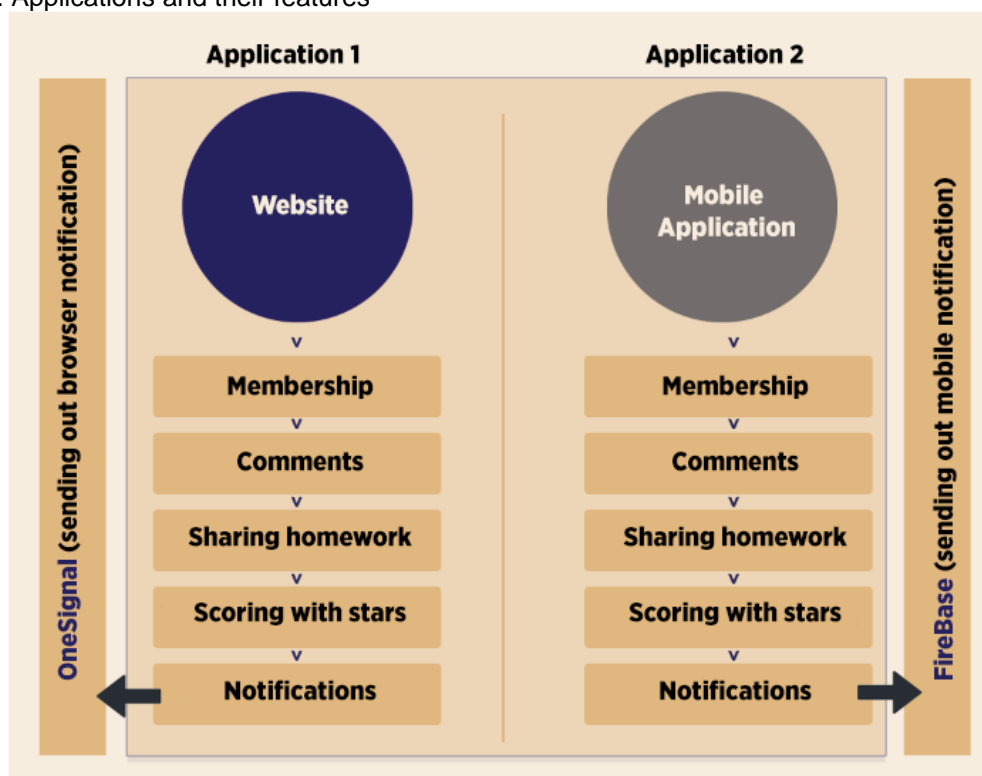
Data Analysis

Within the scope of our study, various data sources were collected, including the 2100-minute recording of the online course, system log records, and emails sent by students. Sentences pertaining to chat messaging during the 2100-minute online course recordings and asynchronous interactions of students during live sessions were identified, documented, and subsequently analyzed. In the analysis of system log records and emails, logs were initially categorized, and then associations between emails and students' system log records were scrutinized. Additionally, meticulous transcriptions of audio recordings obtained from semi-structured interviews and focus group sessions with students were conducted, utilizing the Express Scribe program for text conversion and electronic formatting. Expressions conveying similar meanings in the transcribed audio recordings were categorized, facilitating a detailed analysis process. The content analysis method was employed throughout the data analysis process. The entire dataset was categorized into specific themes based on research questions. The criteria for coding, key terms, and themes used in the analysis were meticulously defined.

The results of the analysis were presented with tables and figures designed to enhance the understanding of the findings. Tables specifically crafted to address research questions were created to highlight key features of the dataset. Furthermore, direct quotations were incorporated to underscore

critical points identified during the analysis process. This detailed analytic approach was designed to ensure a transparent comprehension of the processes involved in data collection, processing, and analysis.

Research's Role

The researchers, who worked as both researchers and system developers in the study, took part at every stage of the action research process. During the ten-week period, they attended and observed all of the lessons. Additionally, they participated in weekly commission meetings to formulate action plans. Furthermore, they developed the applications (the web site and the mobile app) based on the decisions taken in the meetings.

Validity and Reliability of the Study

In order to ensure the validity and reliability of the study, strategies appropriate to the nature of qualitative research were preferred. As Lincoln and Guba (1985) suggest, these strategies are credibility, transferability, dependability, and confirmability, which are discussed below.

Credibility

Lincoln and Guba (1985) recommend that researchers use strategies for prolonged engagement, depth-focused data collection, researcher and data collection triangulation, and peer debriefing to ensure the credibility of their work. While developing data collection tools for the study, expert views were obtained. In addition, interview forms, observation forms, and log records were used for data collection triangulation. Moreover, the researchers attended all the lessons and followed up the web site and the mobile app for prolonged engagement.

The researchers conducted analysis on a weekly basis in order to discuss the findings in the commission meetings, which allowed them to collect depth-focused data. In addition, the findings and interpretations were shared with the participants to ensure that they ran parallel to what the participants really meant, which prevented any misinterpretation. In addition, an expert in the field of qualitative research critically examined all the processes, from data collection to analysis and from findings to results and gave feedback on it.

Transferability

Similar to quantitative studies, there are no generalization concerns in qualitative research (Yıldırım & Şimşek, 2008). In fact, the process is expected to be described in detail (Lincoln & Guba, 1985). Therefore, the sample selection, characteristics of the participants, and environment were explained in detail to ensure transferability. In addition, the findings were presented with direct quotations in accordance with the nature of the data and without any interpretation by the researchers.

Dependability

In order to ensure dependability in qualitative research, the selection of data collection tools and the process of data collection and analysis need to be logical and traceable (Yıldırım & Şimşek, 2008). While developing the interview forms, expert opinions were obtained in terms of the suitability of the interview questions to the research questions, the comprehensibility of the questions, and their suitability to the target audience. The questions in the interview forms were asked to the participants in the same order during the interviews, and manipulative expressions were avoided by the researchers. In addition, the compatibility of the findings with the research questions and theories was taken into consideration.

Findings and Discussions

In this section, the content analysis results of the data obtained from the focus group interviews, semi-structured interviews, e-mails, log records, meeting reports, researchers' diaries, and observations are provided in line with the research questions.

Table 1. What findings are data collection tools associated with?

Data Collection Tools	Learner-Learner Interaction	Learner-Instructor Interaction	Learner-Content Interaction
Researcher's Diary	x		
Commission Meeting Documents		x	
Observation Form	x		
Focus group interview	x	x	
Semi-structured interview	x	x	x
E-Mail			x
Live class recordings			x
Log Records	x		x

Factor Affecting Learner-Learner Interaction

The findings related to the factors that influence learner-learner interaction in an online asynchronous learning environment are provided in Table 2.

Table 2. Factors affecting learner-learner interaction.

İnstructional method	● Assignments with open access ● Quality of homework
Type of notifications	● Reminder and Informative
Technical factors	● System usability ● Technical problems
Individual factors	● Time ● Interest

According to the table, there are four factors that affect learner-learner interaction in an online asynchronous environment; instructional method, type of notification, technical factors, and individual factors. Specifically, asking students to do homework and setting up homework to be seen by the other students are the ways to increase learner-learner interaction. P5 clearly states that, "*Everyone can see others' homework. So, as soon as I realize a mistake in my friends' homework, I contact them.*" In addition, P4 reports that, "*The fact that many of my classmates may read my homework makes me review my homework again and again. We even contact our friends before or after submitting the assignment. Before submitting it, I discuss it with my friends to determine which part of the assignment needs revision.*" This statement reveals that, in order to increase the quality of the homework, students communicated with their peers. In addition, based on the researchers' diaries in week five, there was an increase in students' interactions due to assignments that were public to the members of the class.

Notifications that were sent out on a regular basis are another factor affecting learner-learner interaction. P6 clearly states his interaction with the others after receiving a notification with the following: "*As soon as we receive a notification, we immediately contact each other* and ask, 'Have you seen the notification?', 'Did you see the homework attached?', 'Have you seen your grade?', 'Have you checked out your absenteeism?'. Due to the notifications, our interaction has increased." In addition, when the log records were examined, it was seen that the notification was sent after the 5th week and the interaction of the students with the platform increased as indicated in figure 7. In addition, notifications encouraged participants to communicate with classmates and the instructor. This can be understood from P3's statement "As soon as I receive a notification, I communicate either with the instructor or my friends. It helps with communication.". The log records of P6 and P3 also support these views. It is seen that the interaction in the weeks when the notification is sent has increased more than the other weeks.

Based on the data obtained from log records and e-mails, it is shown that technical factors, such as technical problems and system usability, affect learner-learner interaction. The fact that the system has features that facilitate student communication, and the fact that any technical issue is easily and quickly solved, causes an increase in the level of learner-learner interaction. P1 points out communication via e-mails saying, "*I was unable to review the messages I sent through the web site and I was unsure whether my message was delivered or not. Due to this issue, I preferred sending e-mails to the others rather than communicating with them via the web site.*" P4 states the following in this regard, *"We couldn't comment on homework on the website. When I wanted to comment on my friend's post on our seventh assignment, I had a technical problem. I sent an e-mail to the e-mail address shared on the website. The problem was fixed immediately. I then continued to use the website."*. When the e-mail data is analyzed in addition to the opinions of P1 and P4, it is seen that users interact via e-mail instead of communicating with their other friends when they have technical problems. The positive effects of system usability are also observed in log records. Although the students were only able to make comments on others' assignments, they had the opportunity to score them with stars after the sixth week. Figure 5 provides the frequency rates for the use of the commenting and star scoring features.

Figure 5. Frequency of commenting and star scoring
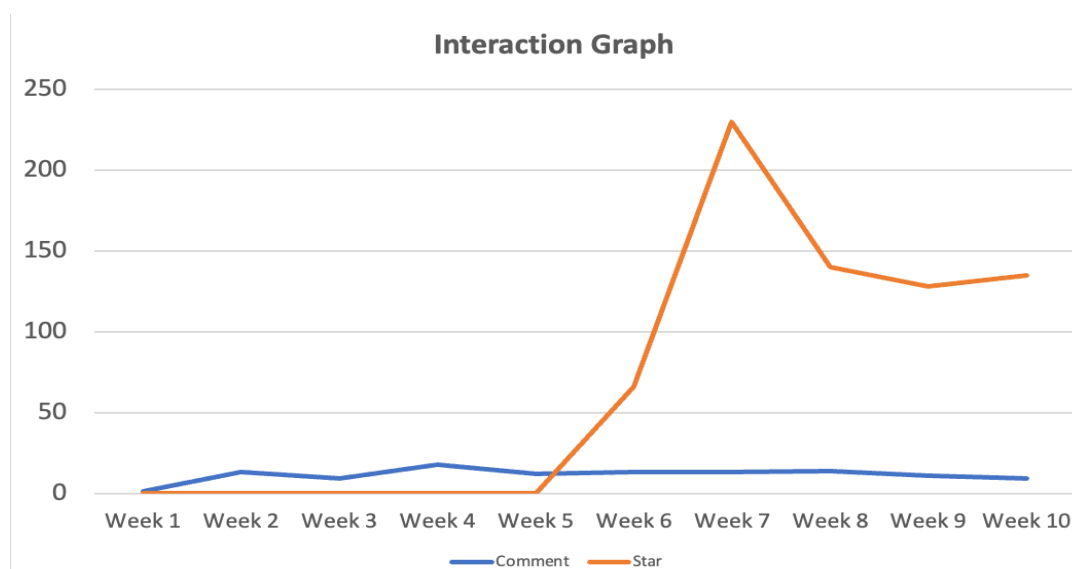
In accordance with Figure 5, the average number of comments per week is fifteen, whereas it escalates to one hundred and fifty for star scoring. The introduction of the star scoring feature in the fifth week, as substantiated by an examination of Google Analytics data, is indicative of a notable surge in system access. P8 states, "*There were times that I did not want to make comments on assignments that I liked*

a lot. But I could give them a star via the mobile application without logging into the system. Due to the system usability, I was able to give feedback to my friends easily and quickly."

In online courses, having sufficient time was another factor that increased learner-learner interaction. One of the participants (P6) states his problem regarding time and how it prevents him from communicating with the others: "*While I am a Master's Degree student, I am also a teacher. I cannot devote much time to my courses and classmates due to my duties at the school I serve.*" On the other hand, a number of students report the ineffectiveness of tools used in online courses on their interaction with classmates. In addition to the opinions of P8 and P6, log records were also examined for the findings of scoring with asterisks. When the log records were examined, it was seen that the number of interactions on the platform increased after week 5. In addition, in the meeting minutes of the 4th commission, the lecturer stated that the students did not write comments and stated that scoring with stars can increase the interaction. When the data in the researcher observation form in week 7 are examined, it is seen that both the commission and the students use star scoring instead of commenting. As a result, the data in the log record, student interviews, commission minutes and research diary show the results that star scoring increases interaction.

P7 states, "*I have access to a computer all the time, so I am not interested in receiving or sending notifications through mobile application. I even turned off notifications in my smart phone, not just for this specific course, but all types of notifications.*". As stated in the researcher observation form, it is seen that P7 does not want to receive notifications due to his individual preferences, and therefore, the notifications do not have an effect on P7.

Factor Affecting Learner-Instructor Interaction

The findings related to the factors that influence learner-instructor interactions in an online asynchronous environment are provided in Figure 6.

Figure 6. Factors affecting learner-instructor interaction
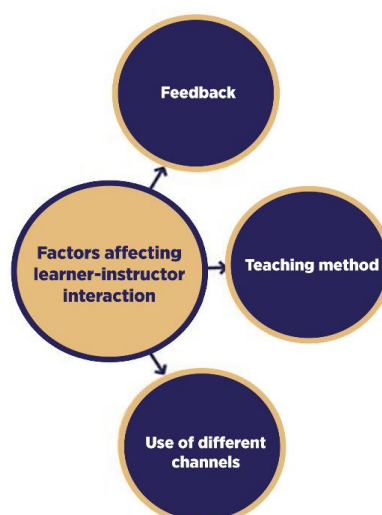
As can be seen in Figure 6, there are three different factors which positively affect learner-instructor interaction in an online asynchronous learning environment; feedback, instructional method, and use of different channels for communication. According to the interviews, feedback and instructional methods are two of those factors. P4 clearly indicates the importance of feedback saying, "*I think our instructor's*

comments on our homework or the feedback he gave us increased our interaction. When he teaches in this way, our interaction with the instructor increases even more.". According to the data stated in the 4th week observation report and also included in the commission report, P4's opinion is supported.

As in learner-learner interaction, it can be seen that the instructor's instructional method affects learner-instructor interaction. In terms of instructional method, use of brain storming, collaborative learning, and team work, which enable students to actively become involved in a learning process, have the power to increase learner-instructor interaction. Specifically, homework that requires teamwork or reflection papers increases ASYNCI. In addition, students' preferences also influence this interaction. In this context, students' use of various channels to communicate with the instructor increases the interaction between the learners and the instructor. P9 states, "*When we encountered a problem, first we sent e-mail to the instructor. Although he wrote back to us about the issue, we preferred to call him in order to clarify things. In other words, we used different channels to interact with our instructor*."

Factor Affecting Learner-Content Interaction

In an online asynchronous learning environment, the factors influencing learner-content interaction are shown in Figure 7.

Figure 7. Factors affecting learner-content interaction
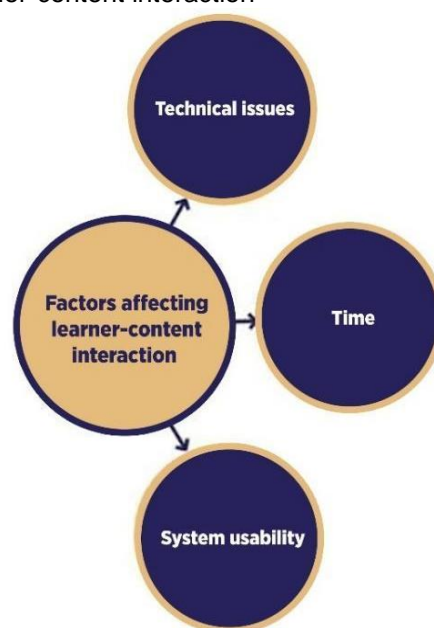
Technical problems, time, and system usability are the three factors affecting learner-content interaction. Specifically, in the interviews, it is revealed that tools that enable students to interact with the content positively influence learner-content interaction. P4 says, "*When I read someone else's homework, I wanted to make comments. However, I was afraid of saying something wrong or inappropriate; then, I mainly decided not to comment. Scoring with stars gave me the freedom to evaluate others' homework and the others did not know whether a star belonged to me or not*." In addition, in the fourth commission meeting, students' hesitation to comment was discussed, which resulted in a decision regarding integration of the scoring with a star feature into the applications. Throughout the implementation, e-mails reveal the negative effects of technical problems on learner-content interaction. In an e-mail, P1 says, "*I was unable to view the messages I sent through the web site and I was not sure you received them or not. Due to this issue, I did not spend much time on the web site and I contacted you via e-mail*.". In addition, when the log records are examined, it is seen that the students send e-mails to both the researcher and the lecturer after using the messaging panel on the system. This shows that they

had technical problems and that they communicated through a different channel after this problem. P1's views show parallelism with this log record.

According to the findings, students' personal issues are another factor that affect their interaction with the course content. Specifically, students who have sufficient time have more interaction with the content. P8 complains about not having enough time to go through everything in the applications saying, "*I did not have time to read weekly content many times. I was only able to review three or four documents in a week.*" On the other hand, students benefit from the notifications by being able to plan their time and interact with the content. P6 says, "*As soon as I received a notification, I organized my plans for that week and set the time to log into the system.*"

Discussion and Conclusion

This action research attempts to identify factors that affect learner-learner, learner-instructor, and learner-content interaction in an online asynchronous learning environment. According to the findings, there are four factors affecting learner-learner interaction; instructional method, type of notification, technical problems (such as non-functionality of website buttons, encountering errors while sending messages, etc.), and individual factors. Specifically, according to the results, setting up homework to be accessible to all course members increases this interaction. Since the assigned homework was open to all members to read or comment on, students may have felt responsible to create a more meticulous and systematic homework. In addition, they were careful not to prepare a similar homework. In addition, public assignments support the advantages of open science. Considering that students are not used to criticizing their peers' posts, thoughts or opinions (Spatioti et al., 2023; Muilenburg & Berge, 2005; Nandi et al., 2012), teachers' encouragement and guidance of students to make constructive criticisms about each other can positively affect interaction among students (An et al., 2009; Alshuraiaan, 2023). In this study, it is shown that learner-learner interaction increases through the notifications sent via the mobile application, since the students had access to their mobile devices anytime and anywhere, which increased their engagement with the course and, as a result, their interaction. In addition to the students' interaction, the instructors' ASYNCI may be increased through notifications. In this context, it is suggested that distance education system developers consider adding a feature to an online course system that enables users to choose how and when to receive notifications.

Another factor that increased learner-learner interaction in the online asynchronous environment is the system usability and the tools that increase communication, which was already an expected result. Other studies reporting similar findings exist (Guo et al., 2009; Jorczak & Dupuis, 2014). In their study, Nyathi and Sibanda (2023) have indicated that the student-student asynchronous interaction is directly proportional to the usability of the systems developed today. The use of different tools in online asynchronous learning environments is a necessity to increase interaction among students. Otherwise, communication among students depends on their habits and the communication tools they currently use. In fact, the research results show that students' habits in using communication tools affect learner-learner interaction. In their study, Attardi, Barbeau and Rogers (2018) state that students mostly prefer the communication tools they are used to in asynchronous learning environments to communicate with each other. However, it is difficult to regulate and examine the interaction among learners when they only use the communication tools they are used to. In this context, use of both available communication tools integrated into the system and communication tools used by students in their daily lives in a hybrid way may yield more effective results in terms of increasing learner-learner interaction in online asynchronous environments. In addition, scoring homework with a star as a gamification element increases the interaction. The students in this study also reported that they preferred this element rather than commenting on their friends' homework since their names were not known by the others when they gave stars and they could do it faster. Therefore, use of gamification elements, such as competitions, badges, and scoreboards may increase students' interaction in online courses.

In terms of learner-instructor interaction, the effects of these three factors were identified; feedback, instructional method, and use of different channels in communication. Thurmond et al. (2002) and Cui

and Zhang (2022) have documented the positive effects of rapid instructor feedback on student performance in web-based learning environments. Providing effective feedback is the responsibility of instructors in online courses, as well as in face-to-face education (Mazzolini & Maddison, 2007; Akkuş & Altay, 2023). In addition, Nandi et al. (2012) reveal that learner-instructor interaction is one of the critical factors that increases students' satisfaction. In this context, it may be concluded that while feedback has a direct effect on learner-instructor interaction, it indirectly influences the success of online courses. Based on this, it is suggested instructors provide quick and constructive feedback to students in order to increase learner-instructor interaction in an online asynchronous learning environment. In addition, Gurjar (2020) reports that the use of new communication tools in online learning environments makes it easier for instructors to provide feedback. In their study, Blauth et al. (2019) work with graduate students and find that the WhatsApp application is one of the applications that ease communication and interaction in an online course. Therefore, the findings related to the effect of students' use of different communication tools on their interaction in an online course support the findings in the literature.

Another aim of the study is to identify the factors that enhance learner-content interaction in the online asynchronous learning environment. Recent studies reveal the critical importance of learner-content interaction in an online setting (Owusu-Agyeman & Larbi-Siaw, 2018; Porter & Graham, 2016; Xiao, 2017, Ahoto et al., 2022). Specifically, learner-content interaction helps students develop their cognitive competence and perception skills (Moore, 1989; Zimmerman, 2012). Wilhelm-Chapin and Koszalka (2020) emphasize that while course content has the potential to get students' attention, it also has an effect on both learner-learner and learner-content interaction. According to the findings, technical problems, time, and system usability are identified as three factors affecting learner-content interaction in an online learning environment. The effects of system usability on learner-content interaction, which is a predicted finding, is also proved by other studies in the literature (Alammary et al., 2014; Attardi et al., 2018; Owusu-Agyeman & Larbi-Siaw, 2018). In this context, in order to establish learner-content interaction, an online system should be user-friendly and technical problems should be minimal. In addition, in order to expect a high-level of interaction between learners and course content, students need to have sufficient time. Studies report that students with limited time have difficulty in interacting with the course content in online learning environments (Peters & Hewitt, 2010; Wilhelm-Chapin & Koszalka, 2020). Therefore, students who are part of distance learning should be provided with guidance in terms of effective use of time.

Suggestions

Recommendations for Researchers: The sample size and demographic characteristics are crucial for the reliability and generalizability of research. Therefore, future studies should consider the demographic characteristics of participants and examine interaction levels. Also, considering different types of notifications (motivational, reminder, informative, etc.) and examining their effects on interaction could be valuable.

Recommendations for Educators: Educators can use various strategies to increase the interaction levels of students. For instance, encouraging students to make constructive criticisms of each other can positively affect interaction among students. Moreover, the interaction levels of teachers should be considered, as they can influence student interaction.

Recommendations for System Developers: System developers may consider conducting a pilot study with the application to prevent technical issues. In addition, the inclusion of a module that allows students to adjust notification timing could help optimize students' time management, facilitate the development of effective learning strategies, and enhance personalized learning experiences.

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Acknowledgements

Funding

Ethics Statement

This study has been conducted based on approvals obtained from the students and the instructor of the course. Both students and the instructor have assessed the explanations regarding the objectives, methodology, and scope of the study, and within this framework, they have granted approval for the continuation of the study.

Conflict of Interest

The authors do not declare any conflict of interest.

Data Availability Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Article History

Suggested citation: