PAPER

Comparative Analysis of the Switching Behavior of Synchronous and Asynchronous Online Learners in Higher Education

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ABSTRACT

This study examines the phenomenon of learner behavior change in synchronous and asynchronous online learning environments. The article assesses the level, stage, reasons, and impact of change among online learners. To facilitate systematic analysis, a set of comparison parameters has been developed. These parameters include success and failure rates, mode and location of learning, level of interaction, group and individualized learning, courses with practical exercises, economic factors, self-regulated learning, indicators of change, technological tools, learner satisfaction, and the impact of a blended learning model. Overall, this article contributes to the understanding of online learners' behavioral changes and provides valuable information to educators, administrators, and online education providers for designing effective online learning environments. The identified parameters can serve as a foundation for future research on how synchronous or asynchronous modes can either enhance or hinder the overall learning experience of online learners.

KEYWORDS

asynchronous and synchronous online learning, massive open online course (MOOC), switching behavior

1 INTRODUCTION

In recent years, synchronous and asynchronous learning modes have become increasingly important, offering new alternatives to traditional, tried-and-tested educational practices [1]. As these two types of training are different, they require distinct preparation, the use of software and hardware tools, and have different requirements for learners and trainers [2]. There are also cases where a combination of the two learning modes is used to teach computer science courses at the university level [3]. Switching behavior can be seen as one of the common tendencies of learners who switch between asynchronous and synchronous modes based on their

personal preferences. However, switching between learning modes has both advantages and disadvantages. For example, when students are required to participate in a course through synchronous teaching with rigid schedules, they have the chance to improve classroom interaction with teachers and other students. However, this approach comes at the price of sacrificing some of the advantages associated with asynchronous learning. In asynchronous mode, students have the opportunity to review course material at their own pace, enabling them to effectively relearn difficult topics if necessary. However, it is not easy for trainers to fully utilize the advantages of one specific mode without compromising the benefits of another. In particular, massive open online courses (MOOCs) are widely popular these days. They are theoretically based on asynchronous teaching and learning. Students prefer content that is available over a longer period of time for better understanding. From the outset, it can be argued that learners should be able to switch seamlessly between synchronous and asynchronous learning modes. This flexibility not only makes it possible to adapt to individual preferences but also ensures the optimal use of learning resources, ultimately benefiting learners from diverse backgrounds.

However, many challenges arise when a course is designed and preferred by learners in only one mode, either asynchronous or synchronous. In this case, it makes sense for trainers to develop strategies to integrate best practices from both asynchronous and synchronous learning modes. In this article, we aim to bridge the gap between these two modes by analyzing the advantages and disadvantages of changing learner behavior.

This paper is organized as follows: Section 2 describes the importance of synchronous and asynchronous e-learning and lists the characteristics of both types of classes. In Section 3, we investigate the reasons for the change in behavior of synchronous and asynchronous online learners. Section 4 lists the evaluation parameters for synchronous and asynchronous learning modes. These parameters indicate how to study behavioral changes and provide guidance and directions for future research. Section 5 presents the discussion, while Section 6 provides the concluding remarks.

2   SYNCHRONOUS AND ASYNCHRONOUS ONLINE LEARNING

Given the global pandemic situation of COVID-19 in recent years, it is natural that many learners around the world are opting for e-learning to enhance their skills. In the face of the upheaval caused by the COVID-19 pandemic, the emergence of compulsory online-only learning has provided a tremendous opportunity for researchers around the world [4]. During the COVID-19 pandemic, higher education faced a pivotal moment, demanding innovation, proactivity, and adaptation to a post-COVID-19 landscape by reimagining its trajectory and implementing essential measures. The significance of the "teacher factor" seems to be crucial for the success of students, who need to continuously adapt to a changing environment throughout their lives [5]. Some researchers have reported on the relevance of online assessment during the COVID-19 closure and the subsequent successful experience [6]. Other researchers have assessed the significance of integrating synchronous lectures and asynchronous support into a unified platform, considering the COVID-19 situation [7]. Furthermore, unlike traditional academic contexts, e-learning encompasses a diverse range of demographics within the learning audience, including age, nationality, gender, mother tongue, professional status, and income. All these factors

play an important role in the decision-making process of online learners. It is also worth mentioning that these types of learning require different hardware, software, and infrastructure, including various types of software, applications, and electronic devices. The change in infrastructure needs to be taken into account by both the recipient (the learner) and the provider (the trainer).

Massive open online courses are increasingly recognized as a promising means of widely disseminating engineering education. In [8], researchers evaluated six MOOC platform models from the perspective of collaboration and the various types of interactions that occur, including learner-to-learner, learner-to-instructor, learner-to-platform, and learner-to-content. In [9], the asynchronous pedagogical approach is shown to be more effective in improving student performance and interest in learning than the synchronous pedagogical approach. In [10], researchers examined student interactions with lecture videos to assess their impact on the academic success of students enrolled in upper-level blended courses. While a certain level of engagement may be associated with enhanced performance, it does not ensure success. Success in asynchronous courses relies on various factors that need to align effectively with students' unique learning styles. For example, if learners are preparing for synchronous lessons, they need to find a non-distracting location, preferably with appropriate attire, as learners may need to turn on their cameras to interact with their peers in an online classroom. Learners may also need to change their location or seat to accommodate a larger audience. Furthermore, since everything occurs in real-time, learners have the opportunity to view other participants and engage in real-time chat discussions. In a broader context, this setting is very similar to that of a typical university classroom. However, there are several limitations in terms of flexibility, quality of material presented, and efficient use of time.

In contrast, asynchronous learning is more personalized, with learners free to choose the time, place, dress, and pace of learning. Researchers have been very positive about the success of this approach, believing that unlimited flexibility can bring substantial benefits to both teachers and students. However, it has been shown that while this mode may initially attract a large audience, learner participation and engagement tend to diminish after a few weeks of learning, leaving the benefits uncertain. This trend motivates the idea that further research should be carried out to understand learners' needs regarding the transition between synchronous and asynchronous learning environments.

Considering the cost of the course and the effort required for development, there are advantages and disadvantages to implementing both synchronous and asynchronous teaching. In general, synchronous teaching requires less cost and development effort, as lessons can be implemented by one or several instructors with limited resources. The main cost of developing a course lies in paying the instructor(s), while the course provider simply has to provide the software environment to deliver the course. In comparison, producing high-quality videos in asynchronous mode requires a significant amount of time, effort, and investment. Software support for online storage, especially cloud-based storage, can demand significant effort. When courses are designed for users in various geographical regions, course developers must exert additional effort and allocate more resources due to various challenges. These challenges include translating media, offering subtitles in multiple languages, safeguarding privacy, and enhancing course accessibility in regions with limited bandwidth [11]. Additional efforts are also required on the receiving end, as learners need to make several adjustments to adapt to an asynchronous learning environment. It can be argued that the restriction of synchronized courses mainly

affects the receiving party, as learners have to remain active during designated lesson times and organize their schedules around a fixed timetable. Constraints on the delivering party are relatively limited because instructors can fulfill their duties and responsibilities within a specific timeframe. On the other hand, the limitations of asynchronous learning primarily stem from the supply side. Providers need to be active throughout the term because there are no fixed times for learners to register for courses or submit assignments. Learners have the freedom to learn anytime, anywhere, and at their own pace. Table 1 lists the characteristics common to these class modes.

Table 1. List the common features and characteristics of synchronous and asynchronous online courses

Common Features	1. Submission of homework or assessments online. 2. Engaged times or click counts checking. 3. Chat features. 4. Participation in video or web conferencing, and live stream video participation. 5. Access of digital learning materials. 6. Discussion boards. 7. Social networking. 8. E-mails. 9. Blogs. 10. Use of online learning environments such as LMS (Learning Management System), VLE (Virtual Learning Environment), or MOOC platforms.
Synchronous Online Classes	1. Rigid schedule, less flexibility, and fixed time. 2. Possibility of real-time interaction with instructor and fellow classmates. 3. Probability of completion of course within fixed time frame. 4. The instructor's pivotal role as the focal point and primary evaluator in determining student progress and assessments. 5. Familiarity between learners and instructors, including teaching assistants (in most cases). 6. Manual grading of assessments by instructors instead of automated grading or peer-grading. 7. Higher flexibility to face-to-face interaction with instructors and fellow learners. 8. Flexibility for fellow students to actively help other learners. 9. Suitable for full-time learners. 10. Higher probability of technical difficulties and practical problems which may lead to stress on learners. 11. Real-time presentation of lectures.
Asynchronous Online Classes	1. Higher flexibility because learners can attend the classes on self-paced mode or semi-self-paced mode. 2. Less possibility of real-time interaction with the instructor. 3. Immediate feedback provided by automated marking system (or Chatbots) available on the learning platform. 4. Suitable for working individuals and part-time students 5. Anonymous fellow learners. 6. Less flexibility for fellow learners to support each other. 7. Assessments provided by combination of teaching assistants, instructors, peer learners (peer-grading) and automated software. 8. Lower flexibility to face-to-face interaction with instructors and fellow classmates. 9. Lower probability of technical difficulties, and practical problems which lowers the stress on learners. 10. Prerecorded lectures, subtitles, transcripts and translated materials. 11. Low burden on using specific device, or learner engagement with the platform.

3 ONLINE LEARNERS' SWITCHING BEHAVIOR

Previously, researchers have extensively studied users' change behavior in online services [12] and social networking sites [13], but there is little research on learners' change behavior in e-learning. Today, however, e-learning can be considered both a product and a service. What's more, no service is immune to limitations or problems. The intention to change the learning mode arises when learners encounter drawbacks in a mode that no longer suits their needs. For example, researchers have found that synchronous interactions in online postgraduate courses present challenges that hinder efficiency [14]. In addition, synchronous and asynchronous discussions in online learning environments have their advantages and disadvantages [15]. Instructors' teaching styles can also have an impact on students' progress in synchronous and asynchronous learning environments [16].

As part of a post-graduate course titled "Probability and Statistics for Engineers and Scientists" offered by the University of Virginia's School of Engineering and Applied Sciences, a decision was made to transition from the traditional synchronous learning mode to an asynchronous learning environment. This change was made to address some of the challenges encountered by the university. However, it also brought new administrative, support, and teaching challenges [17].

This study aims to address the following five fundamental questions:

1. If a student is enrolled in a synchronous course that is also offered in an asynchronous format, what factors might influence the student to transition to the asynchronous course?
2. If the learner acquires most of the skills in an asynchronous course, what impact do the acquired skills have on the synchronous course provider?
3. What are the main reasons why learners switch between synchronous and asynchronous modes, and vice versa?
4. How can course designers minimize switching behavior to increase efficiency?
5. What course considerations and infrastructure changes are needed to minimize switching behavior?

To assess the true advantages and disadvantages of a learning mode, we need to delve into the reasons for transitioning from one mode to another. Previous studies have examined synchronous hybrid learning environments, which involve simultaneous on-campus and online conferencing [18]. The shift from traditional to synchronous and then to asynchronous modes is explained by the limitations of instructor management within the institution providing the instruction. However, studies on behavior change from the learner's perspective are rare.

We identify the following three common features of the two modes: (1) Both modes required a stable Internet connection to access the courses. (2) Learners can attend classes from anywhere. (3) There is a facility available to communicate with instructors regularly. To evaluate the switching behavior, we need to understand which behavior is shifting among learners from one to another. In this study, we identified the following patterns:

Level of switching: Here, the level of switching refers to either the entire course or a few chapters. Sometimes, after watching several videos or attending synchronous or asynchronous learning sessions, students may prefer one over the other. In that case, the reasons need to be collected to confirm whether the learner made the decision to switch for the entire course duration or only for a few chapters.

Stage of switching: In this case, evaluation can be performed to determine at what stage students decided to switch. For example, switching may occur at an early or late stage of the course. A few weeks after the course has started, learners may prefer to switch to an asynchronous mode so they can catch up on any missed classes. In contrast, students who wish to complete a course promptly may opt for synchronous mode during the early stages, as this mode would allow them to receive more guidance from teachers. The strict deadlines for attending classes and submitting homework can motivate students to finish the course promptly. It is also worth noting that learners' previous study experience might play a role in their choice of course mode.

Reasons for switching: This paragraph outlines the fundamental reasons for making a switch. These reasons may be technical or non-technical. The non-technical reasons include: (1) being unable to attend the synchronous classes on fixed schedules; (2) difficulty maintaining a high attendance rate; (3) being unable to submit the homework or assessments before the deadline; (4) preferring self-paced learning; and (5) reasons for travel, part-time employment, and family responsibilities. The technical reasons include (1) delay in establishing connection to the main server during the joining of a course session, (2) Internet breakdown during the synchronous lecturing, (3) preference to view the pre-recorded lectures multiple times, (4) preference to download the course contents such as videos and audios and watch them on multiple devices, and (5) preference to watch the lectures with subtitles, lecture transcripts, and with slow or high speed play options. Other factors can also be considered, including learners' experience, preference for a particular instructor, and the suitability or availability of specific software or apps.

Impact of switching: Another aspect worth investigating is the potential impact of switch behavior on learners' performance, including (1) implications of switch behavior on the submission of homework and assignments, (2) influence of switch behavior on the quality of assignments, (3) relationship between switch behavior and the drop-out rate, (4) comparative analysis of data gathering for instructors across different modes of learning, (5) factors affecting student-instructor interaction in different learning modes, (6) utilization of multiple devices by learners, such as notebooks, iPads, or mobile phones, and (7) future learner interest in the same mode of learning.

4 DEVELOPMENT OF COMPARISON PARAMETERS

This document focuses on the key challenges outlined above. In particular, we identify parameters for comparing best practices (refer to Table 2). In a typical experiment, one might start by comparing at least two sample courses as a case study. For example, a course titled "*XTitle*" is expected to be accessible on a MOOC platform for university students in asynchronous mode. The same course is offered online by a teacher at a local university in synchronous mode. Students are advised to register for both courses and are asked to follow the instructors, assuming that the instructors, university, and students agree to this arrangement. This condition is necessary because the main objective is to assess students' behavioral changes anonymously in order to avoid any bias or emotional attachment to the institution offering the course.

Table 2. Development of comparison parameters and questions for analyzing switching behavior to accurately assess the advantages and disadvantages of the two modes

Comparison Parameters	Details
Success and failure rates	According to previous studies, in the asynchronous mode of learning styles such as in MOOCs, the drop-out rate is high, and the success rate is very low [19]. However, there is not enough data available regarding the success rate of a course which is offered in synchronous mode. Therefore, one parameter is to compare the success rate of a course delivered in synchronous and asynchronous mode simultaneously.
Mode of learning	The second parameter is to evaluate which mode of learning seems to be more credible to learners, the possible metrics to evaluate the credibility criteria of decision making.
Place of learning	The third parameter is about the impact on learners residing in local areas and in remote places such as in different countries. For example, synchronous courses could attract a larger local audience over global audience because course information can be disseminated comfortably when teachers and students are in the same time zone. Moreover, availability of seamless Internet connection is essential in synchronous mode of learning. Considering this it is important to investigate such factors which fall beyond the control of both delivering and receiving end.
Level of interaction	Another parameter to consider is the level of interaction between learners and teaching staff. This parameter encompasses factors such as the reasons behind students' preferences for a particular mode and how that mode can facilitate increased interaction. Previous studies have focused on various aspects of collaborative learning [20], significance of immediate feedback in synchronization classroom settings [21], feedback monitoring [22], synchronous interactions [23], asynchronous online discussion [24, 25], discussion in e-learning, and mobile learning environments, [26], forum discussions in online learning [27], and online discussions in asynchronous learning [28] among others. In synchronous online classes, students are able to listen to the instructor in real-time, and chat or interact with other fellow classmates. However, research also shows that online discussions in asynchronous learning fail to encourage student learning, unless they are motivated to higher-order thinking [29]. The study of asynchronous mode of learning would be interesting because such learning happens individually rather than collectively. Therefore, this parameter focuses on identifying the key indicators of increased interaction. The aspects to consider encompass: **1.** The potential benefits derived from formal or informal interactions between learners and teaching staff. **2.** The ease of forming learning communities and sharing study materials in either synchronous or asynchronous mode. **3.** The various methods through which collaborative learning can occur, such as face-to-face interactions or solely in an online environment, within both synchronous and asynchronous modes.
Collective and individualized learning	This parameter is about the impact of collective and individualized learning. In asynchronous mode of learning, as learners may access materials in different time frames and study the courses in a self-paced way, it is hard for fellow classmates to discuss a particular course topic. In this scenario, the aspects that need to be evaluated include **1.** The mode that promotes collective or individualized learning and the underlying reasons for such an effect. **2.** The major factors that influence the division between collective and individualized learning. **3.** Methods to personalize learning materials, ensuring easy access, comprehension of course contents, and alignment with the instructor's teaching style.
Courses including practical exercises	When the course incorporates laboratory exercises, the following key differences arise in managing course objectives between synchronous and asynchronous learning modes: **1.** The distinctions in managing laboratory exercises between synchronous and asynchronous learning modes. **2.** Evaluation of the effectiveness of each approach in managing laboratory exercises and the reasons supporting their effectiveness.
Economic factors	Within the domain of economic factors, the following considerations arise: **1.** The development cost of course materials and the mode that incurs a significant financial burden, and the reasons behind it. **2.** The impact of the financial burden on course instructors and learners. **3.** Potential financial benefits for instructors and learners associated with opting for a particular learning style.
Self-regulated learning	It is widely discussed in academic literature about self-regulated behavior and online learning [30]. Self-regulated learning is about how the students master their own learning to achieve higher performance through self-directed processes [31]. In asynchronous mode of learning, self-directed learning plays a major role. Considering this, the impact of synchronous and asynchronous learning on self-regulated learning processes is worth examining.

(Continued)

Table 2. Development of comparison parameters and questions for analyzing switching behavior to accurately assess the advantages and disadvantages of the two modes *(Continued)*

Comparison Parameters	Details
Learner satisfaction	When learners have the flexibility to switch between synchronous and asynchronous modes of learning, it offers them greater control over their learning process. This adaptability enables students to tailor their learning experience to suit their individual needs and preferences, whether they thrive in real-time interactions or prefer self-paced study. By accommodating diverse learning styles and schedules, this approach can enhance learner satisfaction, fostering a sense of empowerment and engagement with the educational material.
	Studies have delved into the domain of student satisfaction to ascertain potential correlations between personal contentment and academic performance [4]. In [4], a hybrid model has been devised, leveraging 24 critical variables as predictors, with a specific focus on forecasting student satisfaction. In the realm of asynchronous teaching, studies have been conducted to provide instructors with feedback and actionable recommendations for incorporating into their teaching modules. These efforts aim to ensure students' access to new knowledge and enhance their engagement and satisfaction in diverse learning environments, including face-to-face, distance, or hybrid settings [32].
Indicators of switching	Indicators of switching between asynchronous and synchronous online classes, as well as the main reasons and the advantages and disadvantages associated with such switching, are essential aspects to consider.
Technological tools	In [33], it is found that using technological tools were positive in enhancing students' attitude and perceptions towards them, including those which were not used by students before such as podcasts, online tests, and videocasts. In terms of software and hardware tools utilized by instructors and learners, it is important to assess the cost-effectiveness of each mode and the underlying reasons. Furthermore, with regard to switching behavior, awareness of the necessary adjustments by both learners and instructors is crucial.
Impact of blended model	Currently, there is little evidence to prove the relationship between blended learning designs with active learning [34]. In blended synchronous instruction model, there are different teaching and learning outcomes and unexpected patterns of interactions [35]. Given these considerations, it is crucial to analyze how our approach to understanding switching intentions and behavior impacts pedagogical approaches employed by instructors and the learning patterns of students. In determining the effectiveness of the blended model incorporating asynchronous and synchronous approaches, several factors need consideration to facilitate an effective academic environment. This is particularly crucial during the global pandemic, which presents challenges such as social distancing [36], while universities aim to maintain the normal functioning of their campuses. An important aspect to examine is whether the blended model can contribute to reducing drop-out rates.

5   DISCUSSION

According to existing scientific literature, e-learning platforms and methods are largely based on synchronous and asynchronous learning. Studies have shown that the synchronous mode has emerged to solve several problems faced by universities, such as limited human resources, infrastructure constraints, and inadequate academic facilities [37]. In other words, the transition from traditional synchronous mode to asynchronous mode was made to address challenges related to balancing research commitments, classroom attendance, full-time employment, and logistical constraints like travel, family responsibilities, and qualifying exams [17]. The synchronous e-learning mode presents several challenges, including poor audio and video quality, an unreliable Internet connection, difficulties in managing daily priorities, and inadequate online technical support [38].

Attempts have also been made to integrate the best practices of synchronous and asynchronous learning. It turns out that the level of integration of software tools is limited [39]. If we consider the different types of distance learning, namely distance learning and e-learning, these two modes are very important. In current situations like the global pandemic, students worldwide are increasingly resorting to e-learning, which is not only flexible but also convenient. When it comes to choosing e-learning, most learning content is presented in the form of text, audio, video, and graphics [40]. In applications that offer synchronous and asynchronous e-learning,

there are live audio and video streaming functions, as well as screen sharing [41]. It has also been found that when materials involve problem-solving skills, the combination of video and audio with synchronized text content yields the best results [42]. Most of the content is available from various course providers.

In this context, it is crucial to understand the existing methods for delivering course materials, which are either synchronous or asynchronous. The choice between the two options has several consequences for course providers and learners alike. Course designers tend to consider the various options available to them and determine which mode is most suitable for engaging learners. Learners also have different preferences and can choose the one that best suits them at the appropriate time. As MOOCs developed by reputable universities reach every corner of the world, an increasing number of students tend to enroll in these courses, as most of them are free. The main aim of this article is to investigate the reasons, behaviors, and impacts associated with the change process when choosing between synchronous and asynchronous learning modes.

6 CONCLUSIONS

It can be argued that synchronous e-learning is an improvement on traditional classrooms and that asynchronous e-learning evolves from the best practices of both. The synchronous style can offer various advantages, such as real-time sharing of ideas, instant understanding of concepts, and expert advice from instructors in a synchronous manner. This is a significant advantage when it comes to completing course content. It's safe to say that speed and progress in completing a course are guaranteed if learners adhere to best practices.

However, the asynchronous mode offers alternative options with greater flexibility in terms of access to materials and deadlines for assessment or submission of assignments. Therefore, many learners can easily transition to this self-paced learning mode. The asynchronous learning mode incorporates the best practices of the synchronous learning mode, with the primary responsibility for completing the course falling on the learners. With this in mind, our aim is to evaluate the best practices of these two modes and identify which features of both are most attractive and appealing to learners.

In conclusion, our study provides valuable information on learners' behavioral changes in the context of synchronous and asynchronous learning modes. This study has enriched the body of knowledge on the behavioral changes of online learners in synchronous and asynchronous learning environments. By examining the level, stage, reasons, and impact of change in online learners, we developed a set of comparison parameters for analysis. These parameters include various aspects such as success and failure rates, learning modes and locations, levels of interaction, group and individualized learning, practical exercises in courses, economic factors, self-regulated learning, indicators of change, technological tools, and the impact of a blended learning model.

One limitation is the absence of longitudinal data, which would allow us to analyze changes in learner behavior over an extended period, especially in the unique circumstances of the pandemic. Understanding how learners' behaviors change over time may provide insight into the impact of prolonged distance learning and the effectiveness of different modes of meeting learners' needs. Furthermore, our study did not specifically focus on the behaviors and experiences of students with learning difficulties. Studying the changing behaviors of this specific group may reveal unique challenges and help in developing targeted interventions to enhance their online learning experiences.

These limitations offer interesting possibilities for future research. Longitudinal studies can capture changes in learner behavior and explore the factors that influence these changes, enabling us to design more effective learning environments. Further research to understand the behaviors and experiences of students with learning difficulties can enhance inclusivity in online education. By addressing these areas, we can strive to create engaging and supportive learning environments that meet the diverse needs of all learners.

Future research should focus on how this knowledge can be applied to enhance pedagogical approaches in broader institutional and societal contexts. Studying the organizational factors and systemic changes required for successful implementation can inform educational policy and practice. By continually improving our understanding of the evolution of learner behavior and its implications for pedagogy, we can strive to create transformative and effective e-learning experiences in the years to come.

7   REFERENCES

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