UNIVERSITY STUDENTS' HOME-BASED LEARNING ENGAGEMENT IN THE SYNCHRONOUS ONLINE COURSE: THE PERSPECTIVE OF EDUCATIONAL ECOLOGY

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Synchronous online courses have received wide attention during the COVID-19 pandemic. Students had to attend classes online at home or in dormitories instead of face to face. Learning engagement in synchronous online courses is an important indicator in evaluating the quality of online teaching and learning. Therefore, using a questionnaire, in this study the factors that affect university students' learning engagement in home-based synchronous online courses were investigated from the perspective of an educational ecosystem. The results showed that the overall level of university students' learning engagement in synchronous online courses is in a good condition. In addition, there was no significant difference in learning engagement among students of different genders, degrees, disciplines, and living environments. The ecological subjects (i.e., teachers and the student themselves) as well as the ecological environment (i.e., the resource environment) were the main factors affecting the learning engagement in the synchronous classroom.

KEY WORDS: learning engagement, COVID-19, educational ecosystem, synchronous online learning

1. INTRODUCTION

The COVID-19 pandemic has brought about historic changes with respect to global teaching and learning. Traditional teaching methods have had to undergo numerous changes and educators in many countries have found it necessary to transition to online learning platforms to ensure normal curriculum progress (Pather et al., 2020). In order to control the further spread of COVID-19, in January 2020 the Ministry of Education of the People's Republic of China issued an emergency policy called Suspending Classes without Learning Termination (Cen et al., 2020). Although the pandemic prevented students from attending in-person classes, teachers began to teach using Internet platforms, such that students were able to continue learning online instead of face to face. Therefore, the use of synchronous online courses became an important factor in ensuring that students' learning progressed noemally in China.

The synchronous online course discussed in this paper is a form of online courses in which teachers and students can easily communicate in real time. Continuous development of information and communication technology provided a convenient channel for home learning during the pandemic, and promoted real-time interactions between teachers and students separated by time and space. However, there are many problems in relation to home-based synchronous online learning. On the one hand, online learning has some limitations, including the following: student feedback is limited since teachers cannot see their students' reactions; students cannot get timely answers when they encounter problems; students need to be self-motivated; and the possibility that students' health may be endangered by long-term usage of online courses instead of face-to-face instruction (Singh et al., 2021). On the other hand, students were easily disturbed in the home learning environment due to the lack of a good learning atmosphere and learning facilities compared with the school environment. It is difficult to provide students with a

comfortable and quiet learning environment in many families. Hence, the quality of online learning is difficult to guarantee, especially in the home environment.

Learning engagement (LE) is an important index used to evaluate teaching quality and students' learning status. A systematic online learning research review during the age of COVID-19 showed that students' engagement was sometimes lacking due to lack of motivation or interest, stress and boredom, and the distraction caused by the use of electronic devices (Abu Talib et al., 2021). These problems directly influenced the effect of synchronous online learning. Therefore, it is necessary to study the influencing factors of LE in the home-based learning environment. Although the spread of COVID-19 has been under control in China, in some countries it still poses a serious threat. This study not only provides insight into the development experience of online courses for countries that no longer require online classes, but also provides home-based learning suggestions for countries that are forced to continue teaching students using online classes. Many factors influence online learning, which may come from the teachers, students themselves, platforms, environment, etc. Studying the factors affecting LE from a holistic perspective should be considered due to the complexity and interactions of these factors.

The concept of an educational ecosystem helps to clarify the complexity of the relationship between learners, teachers, and the environment. Analyzing the factors that affect LE from the perspective of an interconnected whole is essential. In summary, it is imperative to investigate the influencing factors of home-based synchronous online LE in order to explore which factors affect learning and which factors improve learning in synchronous online classes and which factors promoted the development of synchronous online teaching during the COVID-19 period. Thus, the research questions asked in this study were the following:

- 1. What is the current situation of university students' learning engagement in the synchronous online course?
- 2. Do students from different backgrounds have different levels of learning engagement?
- 3. From the perspective of an educational ecosystem, what are the factors that affect synchronous online learning engagement?

2. LITERATURE REVIEW

2.1 Synchronous Online Course

The synchronous online course refers to those courses carried out through the Internet, which is a form of online courses. As is known, massive open online courses have greatly promoted the development of online learning and have brought great convenience to learners (Waldrop, 2013). In massive open online courses, students obtain knowledge, skills, and credits through a series of well-made courses on the Internet, and teachers and students interact in non-real time through the forum. However, in this way, teaching and learning are asynchronous; therefore, students' problems cannot be solved in real time. Students had to study using the Internet because of COVID-19. However, many older teachers have low acceptance of technology and need a lot of time and energy to invest in making online courses. Therefore, it seems difficult to solve the teaching problems during the epidemic by using the form of online courses. With the development of live broadcasting technology, all kinds of live broadcasting platforms have emerged, such as live selling, live singing, and other live forms, which provided conditions for students' home learning during the epidemic period. Synchronous online courses emerged as the times

required. The method used for synchronous online courses does not require teachers to learn complex operations. Compared with previous online learning formats, teachers can interact with students in real time and students' questions can be answered in a timely manner.

Although, to a certain extent, this kind of course solved the problem of learning during the pandemic, there were also some disadvantages. An online learning study conducted during the COVID-19 pandemic showed that students were easily distracted because teachers did not have well-implemented strategies; students were disturbed by the environment, such as noise from family members or neighbors; and students had difficulty concentrating due to the lack of a good learning space (Coman et al., 2020). In addition, students' positive academic self-perceptions and course satisfaction were important factors influencing students' motivation and academic achievement in online learning classes (Hassan et al., 2021). Also, factors connected to the online learning platforms cannot be ignored, such as perceived ease of use and usefulness and the stability of network (Jiang et al., 2021). Thus, the factors that influence the effect of synchronous online courses mainly come from three sources: the teachers, students, and environment.

2.2 Learning Engagement

The concept of learning engagement originated from Tyler's time on task theory (Kuh, 2009). Learning engagement is considered to be the time students spend on learning, which is directly proportional to learning achievement. In order to facilitate the measurement and evaluation of LE, Astin (1999) further refined its dimensions, defining learning engagement as the sum of learners' physical and psychological engagement in learning activities. According to Schaufeli et al. (2002), engagement was defined as a positive, fulfilling, work-related state of mind that included three aspects: vigor, dedication, and absorption. Today, LE is usually used to represent constructs such as quality of effort and involvement in productive learning activities (Kuh, 2009).

Fredricks' three component view of learning engagement is the most widely used model, which indicates that LE involves not only students' engagement in classroom academic tasks, but also students' engagement in non-academic tasks, such as positive mental state, rich cognitive strategies, and emotional expression. In his theoretical model, LE included three aspects: behavioral engagement (BE), emotional engagement (EE), and cognitive engagement (CE). The present study adopted the Fredricks et al. (2004) definition of learning engagement. Behavioral engagement refers to learners' participation in learning activities. Cognitive engagement refers to learners' self-regulation and the use of learning strategies, such as metacognitive and memory strategies. Emotional engagement refers to learners' emotional experience in the learning process, including interest, boredom, happiness, sadness, and anxiety.

In relation to research conducted on factors influencing learning engagement, Martin and Bolliger (2018) studied the effect of interactions in online learning on students' LE, including learner-to-learner, learner-to-instructor, and learner-to-content interactions. The results showed that the interaction between teachers and students was the most conducive to improving students' LE. Bond and Bedenlier (2019) studied the influencing factor system of learning engagement, including the macrosystem, exosystem, mososystem, and microsystem. The macrosystem included social and school factors, such as culture, history, economy, and policy. The exosystem and mososystem included family background, such as socioeconomic status and geographical location. The microsystem included intra-individual factors; learning environment and technology; and student-teacher, peer-peer, and family relationships, such as students' self-concept,

skills, motivation, self-efficacy, sense of community, technology choice, teachers' support, peers' response, and level of parent education. It can be concluded from the literature review that the factors affecting LE mainly come from the students, teachers, and environment.

2.3 Educational Ecosystem

The biological ecosystem is the unity of biology and environment in a certain space of nature, in which organisms and the environment interact and restrict each other, and are in a relatively stable state of dynamic equilibrium for a certain period of time. The idea of a biological ecosystem can also be used in the field of education because the education system is also complex and contains various components, which can be called educational and learning ecosystems. Barron (2006) defined the learning ecosystem as "the set of contexts found in physical or virtual spaces that provide opportunities for learning."

A biological ecosystem consists of biotic (living) and abiotic (non-living) units. The biotic unit is the living organism, including producers, consumers, and decomposers. The abiotic unit is the environment, including the space and energy required by biological activities. Similarly, in the field of education, the learning ecosystem is divided into biotic and abiotic parts. According to Chang and Guetl (2007), the learning communities and other stakeholders—such as teachers, tutors, content providers, instructional designers, and pedagogical experts—are the biotic parts in the learning ecosystem. The abiotic parts include the learning media, technology, and tools applied in teaching methods. As this relates to an elearning ecosystem, the instructional designers and information technology support groups are added in as other stakeholders.

Based on a review of the literature on learning ecosystems, the synchronous online learning ecosystem used in this study was constructed in order to explore the influencing factors of learning engagement in a synchronous online learning education ecosystem from a holistic and comprehensive perspective. As shown in Fig. 1, the living parts include the producers who design and teach courses (such as teachers), consumers who acquire knowledge from courses (such as students), and the decomposers who help students digest courses (such as the teaching manager and technical supporter). The non-living parts include the family, platform, resource, network, and social environments.



FIG. 1: Educational ecosystem for home-based synchronous online courses

3. METHOD

3.1 Participants

A total of 234 participants from two four-year provincial key universities in China responded in the online survey. The participants were mainly from eastern China, including Shandong (43.59%), Jiangsu (21.37%), and Zhejiang (13.25%). Among them, sophomores account for 23.93%, followed by freshmen (22.22%), postgraduates (20.94%), seniors (18.38%), and juniors (14.53%). Boys accounted for 24.36% and girls accounted for 75.64% of the participants. Among the major types, liberal arts students represented the largest group (50.85%), followed by science and engineering students (36.75%), and arts students represented the smallest group (12.39%). In addition, 55.13% of the participants lived in cities and 44.87% came from villages and towns.

3.2 Materials

From the literature review, the learning engagement scale was initially determined. Based on the LE questionnaire compiled by Gunuc and Kuzu (2014) and the distance learning engagement scale revised by Sun and Rueda (2012), the LE scale for the live classroom was initially developed, which was divided into three dimensions: behavioral engagement, emotional engagement, and cognitive engagement. Through item analysis of the questionnaire, 11 questions were finally obtained, in which behavioral engagement included three items (BE-1, BE-2, and BE-3), cognitive engagement was composed of four items (CE-1, CE-2, CE-3, and CE-4), and emotional engagement included four items (EE-1, EE-2, EE-3, and EE-4) (Table 1).

Next, according to the ecological system of synchronous online courses, a questionnaire on ecological factors was initially compiled, and 12 final questions were formed (Table 2). Finally, the questionnaire was composed of three parts, including basic information (gender, degree, disciplines, and background), learning engagement, and ecological factors, with a total of 27 items. The questionnaire items scoring method used a 5-point Likert scale (Boone & Boone, 2012), where 1 = strongly disagreed and 5 = strongly agree. The higher the score, the higher was the degree of learning engagement. Reliability and factor analyses were conducted using the SPSS 24.0 software program to test the reliability and validity of the questionnaire. The results showed that the internal consistency coefficient (Cronbach's α) was 0.873 (Cronbach, 1951) and the measure of sampling adequacy [Kaiser–Meyer–Olkin (KMO)] was 0.818 (Kaiser, 1974), which indicated that the questionnaire had good reliability and validity.

3.3 Procedure

The questionnaires were sent out through the Internet to the two universities to collect data. A total of 234 valid questionnaires were collected. The SPSS 24.0 software program was used for descriptive statistics and correlation analysis. First, information regarding the university students' situation in relation to LE in the synchronous online course was obtained by descriptive statistics. Second, the differences in LE among different groups were analyzed by independent sample *t*-test and variance analyses. Third, through correlation analysis, the relationship between each component of the synchronous online ecosystem and LE was explored. Finally, conclusions were drawn through data analysis.

TABLE 1: Items of on the learning engagement questionnaire

ltem Number	Learning Engagement Item						
	Behavioral engagement						
BE-1	I can listen to the teacher carefully in synchronous online courses.						
BE-2	I read the learning materials provided by my teacher.						
BE-3	I can interact/communicate with my teachers.						
	Cognitive engagement						
CE-1	I read extra materials to learn more about things we do in the online class.						
CE-2	When I read the course materials, I ask myself questions to make sure I understand what it is about.						
CE-3	I can arrange my learning time reasonably.						
CE-4	If I do not know about a concept when I am learning in the online class, I do something to figure it out.						
	Emotional engagement						
EE-1	I like taking the synchronous online class.						
EE-2	The synchronous online classroom is a fun place to be.						
EE-3	I feel happy when taking synchronous online classes.						
EE-4	I like communicating with teachers when taking synchronous online classes.						

TABL	E 2:	Items or	the	ecological	factors	questionnaire
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Subject/Environment	Ecological Factor Item
Producer/teacher	1. The interaction or questioning of teachers in synchronous online classes can promote my study.
	2. In the synchronous online course, the teacher's teaching method will affect my learning interest.
Consumers/students	3. I can actively interact and have discussions with others.
	4. I believe I can learn as much knowledge as in the face-to-face classroom in the synchronous online class.
Decomposer/teaching administrators	5. The regulations of the college or teaching administrators have an impact on my study.
Family environment	6. Parents or other people's interference affected my ability to learn.
	7. The learning equipment at home has an impact on my live class.
Network environment	8. The instability of the network environment has an impact on my study.
Platform environment	9. The learning platform lacks some functions, which affects my learning.
Resource environment	10. Synchronous online courses can get more learning resources, which is helpful for my study.
	11. It's easy for me to search and access Internet resources.
Social environment	12. The policy directives of the education department have an impact on my study.

4. RESULTS

4.1 The Current Situation of Synchronous Online Learning Engagement

The mean score of each item in the questionnaire was greater than 3.00 (Table 3), which showed that the overall LE in home-based synchronous online learning was good. In the BE dimension, a mean score of 4.06 was obtained for "I can listen to the teacher carefully in the synchronous online course" (M > 4), which indicated that most students can concentrate on their studies in home-based synchronous online courses. In the CE dimension, "if I do not know about a concept when I am learning in the online class, I do something to figure it out" had a higher mean value (M = 3.69), while "when I read the course materials, I ask myself questions to make sure I understand what it is about" had a lower mean value (M = 3.41), which demonstrated that students had a certain degree of self-regulation, but lacked the ability of independent thinking. In the EE dimension, the mean score of "I like taking the synchronous online class" was higher (M = 3.46), while "I like communicating with teachers when taking the synchronous online class" was lower (M = 3.19).

Item	Number	Minimum	Maximum	Mean	SD
BE-1	234	1	5	4.06	0.872
BE-2	234	1	5	3.72	0.920
BE-3	234	1	5	3.57	0.892
CE-1	234	1	5	3.57	0.911
CE-2	234	1	5	3.41	0.928
CE-3	234	1	5	3.43	0.952
CE-4	234	1	5	3.69	0.908
EE-1	234	1	5	3.46	1.053
EE-2	234	1	5	3.41	1.066
EE-3	234	1	5	3.30	1.079
EE-4	234	1	5	3.19	1.081
	Not	e: SD = stan	dard deviatio	n.	

TABLE 3: Statistical description for synchronous online learning engagement

4.2 Difference Analysis of Synchronous Online Learning Engagement

The data were analyzed to explore the differences in the level of home-based synchronous online learning engagement in relation to different genders, grades, disciplines, and backgrounds. The independent samples test results, given in Table 4, indicated that there was no significant difference (p = 0.78 > 0.05) between the level of LE and gender. There was no significant difference between boys and girls in the levels of BE (P = 0.82 > 0.05), CE (P = 0.55 > 0.05), and EE (P = 0.94 > 0.05). Similarly, the *t*-test results showed that there was no significant difference between LE and the living environment (Table 5) and

degree (Table 6). The results of the one-way analysis of variance (ANOVA) showed that there was no significant difference between LE and disciplines (Table 7).

Engagement		Equality	Confidence for Differe	ce Interval nce (95%)			
Variable	t	df	p	MD	SE	Lower	Upper
LE	0.24	232	0.78	0.30	0.12	-0.22	0.28
BE	0.23	76	0.82	0.03	0.13	-0.24	0.30
CE	0.59	232	0.55	0.07	0.12	-0.16	0.30
EE	-0.82	232	0.94	-0.11	0.14	-0.28	0.26
Note: df = degrees of freedom; MD = mean deviation; SE = standard error.							

TABLE 4: Independent samples test group of gender

TABLE 5: Independent samples test group of living environment

Engagement		Equality of Means (<i>t</i> -Test) Confidence Inte for Difference (
variable	t	df	p	MD	SE	Lower	Upper
LE	0.87	232	0.386	0.08	0.09	-0.10	0.26
BE	1.29	232	0.20	0.13	0.10	-0.07	0.32
CE	0.85	232	0.40	0.09	0.10	-0.11	0.29
EE	0.11	232	0.84	0.02	0.12	-0.21	0.26
Note: df = degrees of freedom; MD = mean deviation; SE = standard error.							

TABLE 6: Independent samples test group of degree

Engagement		Equality of Means (<i>t</i> -Test) Conf for D					ce Interval ence (95%)
Variable	t	df	р	MD	SE	Lower	Upper
LE	1.85	232	0.07	0.21	0.11	-0.13	0.43
BE	1.00	232	0.31	0.12	0.12	-0.12	0.36
CE	1.71	232	0.09	0.21	0.12	-0.03	0.46
EE	1.96	232	0.05	0.28	0.14	-0.01	0.57
Note: df = degrees of freedom; MD = mean deviation; SE = standard error.							

4.3 The Correlation between Learning Ecosystem Components and Synchronous Online Learning Engagement

The analysis of the Pearson correlation coefficient results (Benesty et al., 2009), as given in Table 8, was obtained by analyzing the correlation between each component of the ecosystem and learning engagement. It was generally believed that when r = 0, there was no linear correlation between the two

Engagement Variable	Group	Number	<i>x</i> ±s	F	Р
	Liberal arts	119	3.50 ± 0.72		
LE	Science and engineering	86	3.55 ± 0.68	1.73	0.18
	Arts	29	3.77 ± 0.65		
	Liberal arts	119	3.76 ± 0.74		
BE	Science and engineering	86	3.73 ± 0.79	2.05	0.13
	Arts	29	4.05 ± 0.67		
	Liberal arts	119	3.45 ± 0.78		
CE	Science and engineering	86	3.57 ± 0.78	1.66	0.19
	Arts	29	3.72 ± 0.76		
	Liberal arts	119	3.30 ± 0.94		
EE	Science and engineering	86	3.33 ± 0.88	0.86	0.43
	Arts	29	3.54 ± 0.84		

variables; when $0 < |r| \le 0.3$, there was a weak positive correlation; when $0.3 < |r| \le 0.5$, there was a moderate positive correlation; when $0.5 < |r| \le 0.8$, there was a higher positive correlation; when $0.8 < |r| \le 1$, there was a strong positive correlation; and when |r| = 1, there was a perfect linear correlation (Lard Statistics, 2018; Taylor, 1990).

First, we can see the correlation between the learning ecosystem components and synchronous online learning engagement. It can be seen from Table 8 that the teachers (r = 0.468, p < 0.01), students (r = 0.684, p < 0.01), and resource environment (r = 0.587, p < 0.01) were the most important factors affecting LE in home-based synchronous online courses. It is worth noting that there was no significant correlation between the family environment factors and total learning engagement and each LE dimension. There was a significant correlation between the network environment and behavior engagement and the overall level learning engagement, but the correlation was weak. The correlation between the network environment and the CE and EE dimensions was not significant.

Second, a correlation between the components of the ecosystem was seen. There was a higher correlation between the family and network environments (r = 0.581, p < 0.010), a higher correlation between the resource environment and teachers (r = 0.536, p < 0.01), and a higher correlation between the resource environment and students (r = 0.711, p < 0.01). There was a moderate correlation between the platform and network environments (r = 0.404, p < 0.01), social environment (r = 0.367, p < 0.01), and teaching administrators (r = 0.342, p < 0.01). There was a significant and strong correlation between the social environment and teaching administrators (r = 0.818, p < 0.01). There was a higher correlation between the social environment and teaching administrators (r = 0.509, p < 0.01).

In accordance with the results of the data analysis, the correlation between the ecosystem components and learning engagement is shown in Fig. 2 (the deeper the color, the stronger is the correlation) and the correlation between the ecosystem components is shown in Fig. 3 (the thicker the connecting line, the stronger is the correlation). The students, resource environment, and teachers were the three main factors correlated to synchronous online learning engagement. Similar to a biological ecosystem, the ecological

	FE	RE	PE	NE	SE	TA	S	т	LE	EE	CE	BE
FE	1	_	—	—	_	_	_	_	_	_	_	—
RE	0.054	1	—	—	_	_	_	_	_	_	_	—
PE	0.425**	0.249**	1	—	_	_	_	_	_	_	_	—
NE	0.581**	0.099	0.404**	1	—	—	—	—	—	—	—	
SE	0.384**	0.143*	0.367**	0.306**	1	—	—	—	—	—	—	
ТА	0.325**	0.141*	0.342**	0.347**	0.818**	1	—	—	—	—	—	
s	0.014	0.711**	0.222**	0.128*	0.114	0.160*	1	—	—	—	—	
Т	0.085	0.536**	0.210**	0.095	0.271**	0.274**	0.509**	1	—	—	—	
LE	0.059	0.587**	0.233**	0.133*	0.265**	0.245**	0.684**	0.468**	1	—	—	
EE	0.082	0.559**	0.179**	0.083	0.225**	0.201**	0.659**	0.429**	0.839**	1	—	
CE	0.020	0.498**	0.204**	0.118	0.252**	0.247**	0.550**	0.360**	0.876**	0.571**	1	
BE	0.045	0.439**	0.219**	0.147*	0.203**	0.182**	0.535**	0.409**	0.856**	0.532**	0.708**	1
	Note: * <i>p</i> < 0.05; ** <i>p</i> < 0.01.											



FIG. 2: The correlation between the ecosystem components and learning engagement

components in the online synchronous classroom were interrelated. The social environment had a strong correlation with teachers. The network and family environments were second, followed by the resource environment and teachers.



FIG. 3: The correlation between ecosystem components

5. DICUSSION AND CONCLUSIONS

5.1 Learning Engagement in Home-Based Synchronous Online Courses

The whole situation of university students' synchronous online learning engagement was unexpected. However, it was found that they were able to participate in synchronous online courses with a good mental state. There was no significant difference between gender and grade. A research study conducted by Korlat et al. (2021) showed that there was no significant difference in learning engagement in relation to age for middle school students; however, there was a significant difference in relation to gender. Therefore, further research is needed to investigate the effect of gender differences on learning engagement in university students in synchronous online learning classes. There was also no significant difference in degree and living environment.

5.2 Biotic Units Were Important Factors in Home-Based Synchronous Online Learning Engagement

Through data analysis, it was found that teachers, students, and teaching administrators were the main ecological subjects, where the first two groups had a greater impact on learning engagement. Synchronous online classroom instruction disrupts the spatial relationship between teachers and students. Although teachers and students have classes at the same time, as in traditional classrooms, it is difficult for teachers to interact efficiently with students because of the special spatial relationship. In addition, synchronous online teaching presents a great challenge for many older teachers who are not proficient in emerging technologies. Along with learning computer operation skills to overcome difficulties in using the teaching platform, teachers are advised to explore and study what kind of teaching method can be used in a synchronous online course. For learners, self-regulation and self-efficacy affect their level of learning engagement. Therefore, students should adjust their own learning state when taking a home-based synchronous online course. Self-management and self-regulation are particularly important. For example,

students can make detail learning plans for their own synchronous online courses. In addition, the attitude of teaching administrators (such as leaders of institutes and counselors) to synchronous online learning also affects learning engagement. It is difficult to have a high level of learning engagement without the help and support of teaching administrators.

5.3 The Resource Environment Was the Main Ecological Environment Factor

There was a higher correlation (see Table 8) between the resource environment and learning engagement —as well as BE, CE, and EE—which indicated that the quality of learning resources can impact students' LE. Online courses connected to the Internet provide learners with rich learning resources; however, the quantity of learning resources cannot replace the quality of learning resources. It is difficult for students to find the knowledge they need in various resources if the teacher does not select the appropriate learning resources for students. Resources selected by teachers are presented to students in traditional classrooms such that students do not need to worry about choosing the right resources. However, in a synchronous online classroom, the use of learning resources on the Internet. Therefore, educators and curriculum developers should spend time building excellent learning resources for teachers and students to use.

The social environment, such as education policy, social culture, and public opinion, during the COVID-19 pandemic has affected the learning engagement of learners. In China, the whole country fought against the pandemic, the effects of which changed every day, as reported by various news sources. As a result, policies related to eradicating COVID-19 were changed when necessary. The education department also issued many documents about continued learning platforms at the elementary, vocational, and higher education levels. Students, teachers, education administrators, and parents are all concerned about when they will be able to sit in a classroom again and study in person as before. Therefore, society needs to create a good macro-learning environment for learners' online learning during the COVID-19 pandemic.

5.4 The Influence of the Platform and Network Environments Cannot Be Ignored

The results showed that the correlation between the platform environment and learning engagement, as well as its three dimensions (BE, CE, and EE), was significant. The platform factors such as the stability and the functions of the platform were vital and crucial for learners to have a good synchronous online learning experience. The network environment for LE is equally significant. The instability of a network signal may cause students to withdraw from a live course, and students may not clearly hear the teacher because of a lag in the network audio.

There was no significant correlation between the family environment and learning engagement (see Table 8), which may be due to the home-based learning environment being comfortable for those university students' daily synchronous online classes. However, there were indeed some families that could not provide a suitable desk, quiet environment, stable network, and other necessary conditions for learning because of their economic level. Therefore, a stable network environment and a learning platform with rich functions are required for these students.

In conclusion, this study found that home-based synchronous online learning engagement of university students was at a higher level during the period of the COVID-19 pandemic, and the learning form did not reduce students' learning enthusiasm. In the home-based synchronous online learning ecosystem, every

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ecological component except the family environment affected learning engagement, especially the resource environment and the two ecological subjects (teachers and students) in the ecosystem.

In response to this disaster (i.e., the emergence of COVID-19), the synchronous online learning form has gradually been accepted by teachers and students at all stages of education. Improving teachers' synchronous online teaching strategies is an important factor for ensuring the effectiveness of synchronous online courses. Only by creating a good synchronous online educational ecological environment can the level of learning engagement of learners be guaranteed. More evidence is needed on the impact of the family environment on LE in home-based synchronous online courses. In the future, based on the results obtained in this study, the effect of learning engagement in live online courses should be further investigated in relation to the following three aspects we identified herein: teacher factors, such as teachers' behavior and teachers' language; student factors, such as self-confidence and learning style; and resource factors, such as video and graphic resources.

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APPENDIX A

Table A1 presents the results obtained from the KMO and Bartlett's test. Table A2 gives the results obtained for the reliability statistics.

TABLE A1: KMO and Bartlett's test

KMO measure of sampling adequacy	0.818
Bartlett's test of sphericity:	
 Approximate chi-square 	3307.261
Degrees of freedom	253
Significance	0.000

TABLE A2: Reliability statistics

Cronbach's Alpha	Number of Items
0.873	22