A Qualitative Study on the Model of Factors Influencing Online Interactivity and Student Learning Engagement in the Post-Pandemic Era

Haoqun Yan
Macao Polytechnic University

Hongfeng Zhang
Macao Polytechnic University

Johnny F. I. Lam
Macao Polytechnic University

In the post-pandemic era, online education model has become the new standard in the field of higher education, the interactivity and student learning engagement in online classrooms in higher education has become a major concern for scholars. Using thematic analysis in qualitative research, this study conducted in-depth interviews with respondents to understand the status of interactive strategies used by instructors and students' learning engagement during online learning in higher education institutions in Macao, and to explore other factors that influence interactivity and students' online classroom engagement. Through coding and analysis of interview data, this study found that information technology factors in online classroom instruction in the post-pandemic era affect students' online learning motivation, self-control ability, and formative assessment in the online classroom. Also, online formative assessment, students' online learning motivation, and their self-control ability could influence students' online learning engagement. Based on the findings of the study, this paper proposes recommendations for improving classroom interactivity and student learning engagement in online higher education in the post-pandemic era.

Keywords: online education, interactivity, online learning engagement, online learning technology

INTRODUCTION

Since the outbreak of the COVID-19 epidemic, online learning has gradually integrated with higher education, and the results of online teaching as well as the difficulties and challenges encountered in teaching have attracted widespread attention from scholars. As we progressively transition towards the post-epidemic period, it becomes especially important to address the difficulties and obstacles in online education. Whether it is a live or recorded online class, most college students have accumulated more than an adequate online learning experience, and it is no exception for students in higher education institutions in Macao. According to Zhang's study (2021) on the online learning experience of undergraduate students, we know that Macao higher institutions can use students' learning experience as a starting point to explore

how to improve the quality of online teaching. A good learning experience in the classroom is inextricably linked to the level of interaction, but due to changes in the teaching environment, sometimes the interactivity in the online classroom is not satisfactory enough. Compared with offline teaching, e-learning encourages students to communicate with their peers through cooperative learning, but students have limited opportunities to give feedback to teachers when learning online, which makes the actual online learning effect affected (Means, 2021). Therefore, it is worthwhile to further investigate what interactions in online classrooms and what factors affect them. On the other hand, students' engagement in online learning reflects their identification with, adaptation to, and effectiveness of the current online learning model (Carvalho, 2021). In addition to classroom interactivity, it is necessary to focus on the current state of online learning engagement to identify factors that affect learning engagement and potential links between interactivity and learning engagement, which in turn will help teachers to improve their classrooms and facilitate students' engagement in learning.

However, with the change in teaching mode and learning place, the interactivity in the online learning process has also changed. When the network as a carrier of teaching brings together more diversified teaching resources for the classroom in the post-epidemic period, does it become "a powerful assistant" for teachers' online teaching or an obstacle to teacher-student interaction? What factors influence the use of interactive teaching strategies? This study used thematic analysis and explored the online classroom interactivity and student online learning engagement in Macao higher education institutions. It also found that other factors that affect both respectively, based on the collected interview data, to make suggestions for improving online classroom interactivity and student classroom engagement in the post-epidemic period.

LITERATURE REVIEW

Online Education

Research findings on online education were abundant before the outbreak of the COVID-19 epidemic when online teaching was mainly aimed at training courses conducted by universities, companies, and organizations (Capper, 2001). After the outbreak of the COVID-19 epidemic, most online courses were created as a result of force majeure factors that changed the previous face-to-face instruction to an online teaching model, and as online instruction took place, the problems with this less mature instructional model were gradually identified by educators. Adnan & Anwar (2020) used a questionnaire survey on the topic of "Perceptions of Online Education" among students enrolled in higher education institutions in Pakistan to find out the problems of online education from the student's point of view, and the results showed that the main challenges faced by students at this stage of online learning are lack of interaction in the classroom and inefficient use of internet technology. Using a quantitative research study, Das & Meredith (2021) used a questionnaire distributed to 68 teachers to identify six effective transformational factors that affect the success of online teaching, namely, professional training received by teachers, assessment of student performance, teachers' concern about test cheating, infrastructure difficulties, lack of student skills, and difficulties in online classroom management that could affect the success of online teaching. Therefore, it is easy to find that most of the challenges facing online teaching come from the limitations of the objective physical environment and the lack of subjective motivation of teachers and students for the new teaching model.

In addition, students' self-efficacy in online learning has also attracted scholars' attention. Shen et al. (2013) explored five dimensions of students' self-efficacy in online learning using a questionnaire method in terms of technology, learning, and socialization, and found that students' self-efficacy in completing online courses significantly explained the differences in their satisfaction, suggesting that teachers should adopt a positive interactive approach to further stimulate students' self-efficacy. Thus, there is a correlation between the interaction style and the effectiveness of interaction in online classrooms and students' self-efficacy, so classroom interactivity should be discussed more widely. While discussing students' self-efficacy in online learning, Prior et al. (2016) considered the influence of students' learning attitudes and their digital literacy on self-efficacy. A questionnaire study with 151 participants found that positive

learning attitudes and digital literacy had a significant positive effect on self-efficacy. It is thus evident that students' competence also has a non-negligible role in the online learning process, and a few scholars have explored its relationship with online learning from the perspective of students' self-regulation ability. For example, Gorbunovsa et al. (2016) argued that self-discipline positively influences online learning outcomes, while suggesting that proper use of motivational tools by teachers can help students maintain higher motivation and stronger self-regulation ability. Although self-discipline is an internal individual ability, whether it is influenced by peers and the learning environment when learning in a group online is subject to further research.

When the Internet is used as a medium of instruction, the virtual environment and the technological literacy of teachers and students will affect the effectiveness of student learning (McIsaac & Craft, 2003). Torcivia Prusko et al. (2020) explored how 10 learners who had participated in a MOOC used technology to support online learning by conducting semi-structured interviews from the perspective of online course effectiveness using phenomenological analysis from qualitative research. The results suggest that the flexibility of online classes, while helpful in creating tailored courses for learners, makes them difficult to practice and frustrating due to virtual learning environment limitations. The key challenges posed by online learning that Heng & Sol (2021) talked about in their study include limited technological infrastructure, unequal online educational resources, abrupt changes in the teaching paradigm, heavy workloads in some subjects, and the ability factors such as teachers' inability to use online technologies should also receive attention. Consequently, the focus of online teaching should not only be on the teaching itself, but also on the use of technology, the support of platform functions, and the teachers' and students' technological literacy, which also affects students' online learning outcomes. Liaw & Huang's study (2013) constructs a theoretical model from the perspective of analyzing students' attitudes toward the online learning environment, from which we can see that students' attitudes toward online learning can be divided into three levels, namely, individual characteristics and system performance level, affective and cognitive level, and behavioral level.

Online Classroom Interactivity

Interactivity in online education is often considered an important part of teaching and learning. One study assessed the importance of student-student dialogue and instructor-student dialogue on the effectiveness of online learning, in terms of learning outcomes, the student-student dialogue and student-teacher dialogue were key predictors of online learning effectiveness and may determine the ultimate success of students' online learning (Tsang, 2021). The results of this study implied that the level of interaction in online education may play an important role in student learning outcomes and that the challenges faced in the interaction process need to be given adequate attention by instructors. When information technology is involved in classroom interaction as a medium, teachers can make full use of electronic resources to make learners more autonomous in their learning (Wagner, 1998). Kennewell et al. (2008) focused on the concept of interaction in the context of "teaching and learning" activities and illustrates the role of information communication technologies (ICT) in teaching and learning. This research has shown that technological interactivity is a valuable feature of ICT resources that can stimulate the repetitive practice of skills without the presence of the teacher, and if learners can take advantage of these features when using ICT, we should begin to see the benefits of greater learner autonomy that ICT offers. Information technology can give classrooms and learners much more than just shared learning resources on the web and can develop students' learning skills with the proper guidance from teachers. Even though online classrooms can use more diverse teaching tools to facilitate student-teacher interaction than offline classrooms, classroom management and assessment processes in online learning are a concern according to the study by Mishra & Raina (2021). Accordingly, classroom interactivity may be affected by poorer classroom order and be less effective. Although the teaching model is ostensibly only changed compared to the traditional offline classroom, there is potentially a range of factors that change as a result, thus making distance education more in need of innovative classroom activities to create a positive interactive atmosphere.

Online Learning Engagement

The three classroom engagement strategies commonly considered by scholars include behavioral engagement, cognitive engagement, and affective engagement, with behavioral engagement referring to whether students are actively engaged in learning activities, cognitive engagement referring to whether students are highly motivated, and affective engagement referring to the positive attitude students display in learning (Fredricks, 2004). Oviawe's study (2020) used questionnaires that explored the factors that influence student engagement in teaching, and active learning strategies that promote student engagement. It concluded that student classroom engagement increased when teachers' IT skills were trained and improved, and that student classroom engagement was better when teachers revised their teaching strategies with the times. But this study ignored another subject in teaching, the students, whose existing IT skills should also be valued. Wilson et al. (2020) used an ethnographic study to deeply explore the online learning experiences of four students from different cultural backgrounds, which discussed more students' actual experiences and feelings from their subjective perspectives, and the study found that students' online learning engagement is influenced by four key factors, namely accountability, awareness, socialization, and environment, which suggested focusing on the effectiveness of online learning, students' self-regulation, and the impact on students due to a lack of social connection. Other research has focused on how students from culturally and linguistically diverse backgrounds engage with online learning environments, and findings suggest that building a culturally inclusive online learning environment can help enhance student engagement (Hannon & D'Netto, 2007). Online learning is less engaging than offline classrooms, and current research suggests that online discussions, formative assessments, and other forms of consistent and frequent student-teacher and student-student communication can help enhance student learning engagement and improve learning outcomes (Muir et al., 2020; Douglas et al., 2020). However, the use of information technology to enhance learner-teacher and learner-content engagement in a targeted manner remains an issue for further research.

In general, based on the above literature analysis, research on online learning has mainly used quantitative research methods, focusing on students' self-efficacy, learning effectiveness, and challenges faced by teachers in teaching. However, research on online classroom interactivity and student learning engagement are primarily qualitative in nature. While research on classroom interactivity focuses on interpersonal interactions, students' interactions with learning content should also be considered one of the important interactions. This study will use the thematic analysis method of qualitative research, analyze interview data, refine themes, and construct a theoretical model, focusing on online classroom interactivity and student learning engagement, to investigate the factors that affect them respectively and how they are related to each other.

METHODOLOGY

Research Design

This study used thematic analysis in qualitative research and in-depth interviews with respondents based on constructivist and phenomenological theories to interpret the status of teachers' use of interactive strategies and students' engagement in online training in Macao's higher education institutions and to explore the factors that influence interactivity and students' online learning engagement. Thematic analysis is a method of analyzing qualitative research data that entails sorting and coding qualitative information and then identifying and distilling themes from it. Scholars are often able to use various types of information in a systematic way that enhances their deeper understanding and sensitivity to people and events (Boyatzis, 1998).

The interviewees in this study were all undergraduate students from five higher education institutions (three public institutions and two private institutions) in Macao, majoring in different disciplines, including language, education, tourism, social sciences, computer science, nursing, sports, and so on. The reasons for the selection are as follows: firstly, several universities have different forms and types, and their majors are set in different fields, which helps this study to further consider the expression of online learning interactivity and the room for improvement according to the characteristics of different types and

disciplines; secondly, based on the historical enrollment criteria, student composition and overall teaching style of these institutions, they could better reflect the average situation of regional higher education; lastly, the final selection of interviewees also considered different majors, genders, cultural backgrounds, and student origins, which makes this study generalizable in a broader context.

Data Collection

According to the purpose of the study, a total of 41 participants, 11 males and 30 females, were selected and interviewed in person or online from November 2020 to November 2021. Respondents were coded according to their major, gender, and interview order, L (E, T, SS, CS, NS, S)-F(M)-1 for Language major (Education, Tourism, Social Sciences, Computer Science, Nursing, Sports) - Female (Male) – the first respondent. In addition, all respondents were aware of the purpose of this interview and agreed to use the interview data for this study before being interviewed.

Data Analysis

This study followed the phases suggested by Braun & Clarke (2006) for thematic analysis in sequence, which was familiarizing with the interview data, generating initial codes, finding themes, reviewing themes, defining and naming themes, and producing the report. In the first stage, the researcher transcribed the audio of the participants' interviews into transcripts and read through all the interview data repeatedly to mark the parts that were relevant to the focus of this study. In the second stage, we sorted and classified similar utterances from the interview data and coded them initially. In the third stage, we took the initially coded data and analyzed them further, removing duplicate statements to establish connections between the individual codes, discover their underlying relationships, and then categorized them into different initial themes. In the fourth stage, in which we analyzed the initial codes and initial themes more carefully, appropriate corrections were made, and the sub-themes derived from the themes were recorded. In the fifth stage, the researchers named and defined the themes and sub-themes. Finally, we compiled the interview data related to the themes and sub-themes for the rest of the research discourse. Through iterative analysis of the collected interview data, five main themes and fourteen subthemes were extracted, namely "Sense of spatial difference", "Self-control ability", "Online formative assessment", "IT factors" and "Online learning motivation". And the subthemes were "Lack of communication between teachers and students", "Lack of interaction between students and students outside of online learning activities", "Timely interaction between students and learning materials", and "Students don't have enough concentration during online learning", "Most students have satisfied time-management ability", "Metacognitive strategies affect students' engagement in online learning", "Ineffective 'instant' feedback and improvement in online teaching", "Online assessment promotes student-teacher and student-student communication", "Online assessment enhances students' engagement in learning after online classes", "Online learning effectiveness is affected by the functionality of the online teaching platform and network factors", "Teachers' IT digital literacy can affect online classroom interactivity", "Students' IT digital literacy can affect their online learning engagement", "Intrinsic motivation" and "Extrinsic motivation"(Table 1.).

TABLE 1
ONLINE CLASSROOM INTERACTIVITY AND ONLINE LEARNING EXPERIENCES

Main Theme	Subtheme	Definition
Sense of spatial difference	Lack of communication between teachers and students	Students often do not receive timely feedback from the teacher in online learning
	Lack of interaction between students and students outside of online learning activities	The frequency of interaction among students is reduced except for the time of class discussion, which is not conducive to the formation of good interpersonal relationships among students
	Timely interaction between students and learning materials	Students have timely access to the learning materials distributed by the teacher on the e-learning platform and are able to effectively use the platform features for independent learning
Self-control ability	Students don't have enough concentration during online learning	Lack of self-control ability, external supervision, and learning atmosphere make it difficult for students to stay focused in class for long periods of time
	Most students have satisfied time-management ability	The flexible schedule of some recorded courses in online learning requires students to balance rest and study
	Metacognitive strategies affect students' engagement in online learning	Planning before learning, monitoring cognitive activity during learning, and adjusting cognitive strategies after learning can affect students' online learning engagement and learning outcomes
Online formative assessment	Ineffective 'instant' feedback and improvement in online teaching	The "human-machine" spatial distance prevents the implementation of feedback strategies for teachers and response strategies for students
	Online assessment promotes student-teacher and student-student communication	Online assessment is more varied in most subjects, such as individual and group oral presentations facilitate communication between teachers and students to a certain extent
	Online assessment enhances students' engagement in learning after online classes	The change of assessment format has an impact on students' attitudes, motivation and learning engagement

IT factors	Online learning effectiveness is affected by the functionality of the online teaching platform and network factors	Some features of the teaching platform are beneficial to online teaching, but others may become limiting factors for online learning
	Teachers' IT digital literacy can affect online classroom interactivity	Teachers' familiarity with various online teaching platforms and teaching resources can affect the effectiveness of online classroom performance
	Students' IT digital literacy can affect their online learning engagement	Students' familiarity with and acceptance of the e-learning platform and live online classroom software can affect their online learning experience and learning effectiveness
Online learning motivation	Intrinsic motivation	The intrinsic motivation of online learning mainly comes from their own interest and desire to learn
	Extrinsic motivation	The extrinsic motivation of online learning mainly comes from grades and exams

RESEARCH FINDINGS

Sense of Spatial Difference

Even though the online teaching model provides convenient conditions for distance learning, it also affects students' online learning experience, as the communication between teachers and students is no longer as smooth as in face-to-face classes.

"Compared with offline classes, it is not as convenient for the teacher to answer questions online, and I usually rarely ask questions while the online class is in progress." (SS-M-19)

"Online classes are not very interactive, and I find them a bit boring. Online interaction is mainly text-based, but the interaction is not timely." (CS-F-18)

Human interaction is an emotional experience, and the interaction between teachers and students in higher education can help students build their social personalities (Senthamarai, 2018). When all teaching activities are conducted online, although teachers and students can hear each other's voices and receive information transmitted by each other in real-time through the teaching platform, after all, they are facing a cold screen, which makes many students feel that communication exists at a distance.

"I feel that teacher-student communication lacks temperature and has a sense of distance." (T-F-14)

"It seems that the relationship with the teacher is distant." (E-F-5)

"The poorer emotional experience of taking classes on the computer." (SS-F-20)

This kind of distant conversation makes for a poor interactive experience, and to some extent, it also weakens students' motivation to continue initiating conversations.

"There is nothing intimate about classroom real-time connected communication, I usually communicate with the teacher by email after class to avoid embarrassment, and in general I am more suitable for face-to-face classes." (T-F-7)

Additionally, it is difficult for teachers to perceive students' learning status promptly when teaching online, and it is uncomplicated for teachers to "talk to themselves" and ignore students' main status in the online classes.

"I usually don't turn on the camera, and there is almost no eye interaction between teachers and students. It is hard for the teacher to understand the student's level of understanding through their facial expressions." (T-F-6)

"Teachers can see students' expressions and other feedback to adjust their teaching promptly in the face-to-face classroom, which is difficult to do online." (CS-M-27)

Teacher feedback to students during class is also an important part of teaching.

"After asking a question online if the teacher did not give feedback and ignored the question I asked, I may have developed a negative mindset about the class." (SS-F-33)

Interaction between students includes the information exchanged between learners in chats, discussions, group work, and team activities (Abrami, 2011). Although students can always keep in touch with each other through social software, the interaction in the classroom still inevitably suffers from less overall interaction.

"Sometimes it is not convenient to turn on the voice at home (interference from the surrounding environment)." (SS-F-17)

Effective interactions among students could promote their interpersonal relationships and sense of teamwork, and teachers should consider deeply how to facilitate interactions among students about the content and learning styles of the students they are teaching. Furthermore, the interaction between students and learning materials also deserves our attention. When the Internet is used as the main medium for delivering learning materials, most students report that such a learning experience is satisfying.

"The teacher does not have to hand out paper materials making the class more efficient." (T-F-13)

"My grades improved after implementing online teaching, probably because I was willing to find more materials online to study after class." (CS-F-29)

This reflects the convenience that the Internet provides for students' learning and the fact that the online learning experience enhances their learning initiative and broadens their access to knowledge. Because of the differences in personality traits, learning styles, and adaptability of everyone, some students believe that the "distance" in online interactions has enhanced their learning engagement and self-efficacy.

"I am introverted and prefer to communicate with teachers online but dare not ask questions offline." (E-M-11)

"I can share my ideas at any time in the discussion forum, but I am afraid of interrupting the teacher in offline classes." (E-F-25)

Just as the online environment creates a sense of anonymity, students can ask the teacher more questions than they would in a face-to-face classroom (Vonderwell, 2003). Thus, although this sense of spatial difference in interaction most of the time affects the interpersonal communication experience, for students with introverted students, it helps them to break down the inner barriers that prevent them from interacting and enhances their motivation and engagement in learning.

The popularity of online education has certainly brought more diverse learning opportunities for learners, but also more responsibilities for teachers, with some shifts in the identity of both teachers and learners (Beldarrain, 2006). Whereas interaction is a very important part of the teaching and learning process, facilitating different types of dynamic and collective online interactions is extremely challenging (Childers & Berner, 2000). Moreover, online learning should not only focus on students' rational cognition, but also on their emotional engagement, both of which have an impact on learning effectiveness (Zhang et al., 2021). Vivid classroom discourse, rich classroom activities, and timely and effective feedback have become new challenges for teachers in the era of online teaching.

Self-Control Ability

There has long been a perceived correlation between students' self-control ability and their learning engagement in learning. In the offline teaching process, the teacher's supervision and the learning atmosphere in the classroom can help students with low self-control ability to discipline themselves to a certain extent. However, this also places greater demands on students' self-control ability, mainly in terms of their ability to concentrate in class, their ability to balance rest and online learning time, and the application of metacognitive strategies in online learning.

Firstly, students do not pay enough attention to online learning. Due to the lack of strict external supervision in online classes and students' weak self-control ability, they are easily influenced by the Internet as well as the objective physical environment, so it is difficult for them to maintain their attention in class for a long time.

> *"Due to the lack of teacher supervision and the pressure of offline classes, I often cannot concentrate and feel that I am not listening to the lessons effectively." (SS-M-30)*

> *"I am easily tempted by electronic devices, and I have dropped out of classes in the middle of online learning." (NS-F-34)*

> *"I don't pay enough attention when studying online, partly because my concentration is not enough, and partly because the external environment such as neighbors' renovation and my sister's noise also distract me." (NS-M-38)*

The concentration of students' attention affects their behavioral engagement in class, and it is another challenge for teachers to ensure students' concentration level to improve the quality of their online learning through effective teaching strategies.

Secondly, time management in the online learning process also tests the students' self-control ability. Online education is usually divided into two forms: live classes and recorded classes, while the schedule of recorded classes is relatively flexible.

> *"Students can study on the platform at any time without a fixed time, and the time is more flexible." (T-F-6)*

Students being able to freely choose the class time helps them with strong self-discipline to improve their learning effectiveness.

> *"I will make a schedule to plan what I do when and combine work and rest to avoid wasting time." (SS-F-21)*

Conversely, for students with poor self-control ability, learning is much less efficient than in the offline classroom. In addition, the online learning mode saves students' commuting time, and if they could make full use of the fragmented time, they will also have satisfactory learning outcomes.

> *"Studying in the dormitory can save time to go to school, thus I will have more time to study, and my self-learning ability and grades have improved." (E-F-8)*

> *"The time saved can be used for study, such as reviewing and learning new knowledge, so that I can have a fuller understanding of what I have learned in class and learn more outside of class." (S-M-22)*

Finally, the application of students' metacognitive strategies in the online learning process was correlated with their learning effectiveness and engagement, which were reflected in the pre-learning planning strategies, monitoring strategies during learning, and adjustment strategies after learning. For instance, setting goals in a planned manner before the learning activities began, estimating the extent to which you have reached your cognitive goals, and studying again after class for any deficiencies.

> *"I will adjust my daily learning tasks according to my actual situation, different subjects, and learning pace." (E-F-8)*

> *"I can review it again after the class and during the exam revision period so that I can master some parts that I failed to understand in the class." (CS-M-27)*

> *"The teacher's recorded teaching audio is placed inside the PowerPoint, so we can listen to the parts we don't understand a few more times to supplement our notes in class and deepen our understanding." (NS-M-38)*

Online Formative Assessment

Assessment is an important means to test the effectiveness of student learning, and assessment in online teaching is not the same as in offline teaching, which tends to be in the form of a single subjective quiz and a flexible and diverse assessment (Zhang et al., 2022). Due to the spatial distance of online learning from human-machine humans, the teacher's questions, feedback, student's questions, and teacher's feedback all lack validity due to the separation of a cold screen.

> *"If too many students ask questions online it will be chaotic, and the teacher will not be able to answer in time." (E-F-8)*

Consequently, teachers in some subjects have added diverse assessment tools that help generate interaction to some extent.

> *"Some subjects that require practice, teachers ask us to record videos, and I think this type of assessment is interesting." (S-M-22)*

When the assessment format is no longer limited to completing the paper in a closed examination room, some students reported that the process of preparing an oral presentation is a fun and in-depth learning experience and that students become more adept at using learning resources and increase their engagement in learning as a result. Other online assessment methods besides oral presentation include completing electronic papers with time limits.

> *"I use social software to communicate with my classmates when preparing my reports, and we often drill down on questions together, which seems to bring us closer." (CS-F-29)*

"I am less shy to presentation online." (SS-M-31)

"The familiar environment is relaxing and not affected by other students going through papers, but it is also easier to cheat and not to ask the teacher any questions in time." (NS-F-40)

"Assessment criteria can affect students' motivation to learn, which in turn can affect learning efficiency." (NS-M-39)

Accordingly, the transparency and fairness of the online assessment criteria can also affect students' future classroom engagement.

IT Factors

In the offline classroom, people are generally not unfamiliar with the use of multimedia teaching, teaching aids and projectors have long been regular in the classroom, and with the popularity of online teaching mode, a variety of electronic teaching platforms and teaching live software are gradually applied to the classroom by teachers. After all, the electronic teaching platform is an important medium for online teaching, and the functions of the platform and teachers' mastery of teaching software will affect classroom interaction and students' learning participation.

Due to the limited functionality of the platform and the low level of mastery of the teaching software by some teachers, this could affect students' participation in class.

"Teachers are not fully familiar with the functionality of the live teaching software, and online learning is not sufficiently comfortable and sometimes wastes time." (SS-F-33)

"For skills classes (e.g., Computer technology operation course), the effectiveness of learning is reduced without software support." (NS-M-36)

"The teacher is not familiar with the online platform and the overall classroom effect is not good, especially in subjects that require high interactivity (e.g., Portuguese course)." (T-F-14)

It is expected that information technology as an interactive medium can provide students with a new interactive experience, but each online teaching platform has its focus on development, it is inevitable to hear suggestions from teachers and students of different disciplines for this purpose, and we can perhaps let the electronic teaching media which takes advantage of the strengths and avoid the weaknesses and make clever use of certain functions of the platform to improve the overall teaching effect.

"Both online and offline lectures follow PowerPoint, but it is more convenient to share them online." (SS-F-16)

"Using pictures and animations in online teaching with the advantage of the platform will be more vivid." (E-F-23)

"Ding Talk has a playback function, teachers can see the length of time students watch and the unwatched list, which is good for supervision." (CS-F-18)

"Tencent Classroom can give teachers praise and flowers, which can liven up the classroom atmosphere and make more students participate in the classroom." (E-F-24)

"Using Kahoot! to conduct quizzes can liven up the classroom atmosphere and stimulate students' motivation and engagement in the classroom." (NS-M-36)

As Revere & Kovach (2011) suggested using appropriate technology to bring classroom content to life, can increase students' learning engagement. Even so, network instability often affects teachers' classroom instruction and students' learning effectiveness and classroom participation.

"The problems such as network delays can lead to poor learning." (SS-F-33)

From the students' point of view, the change of teaching mode requires, to a certain extent, students' self-regulation to adapt to the new learning style. Students not only need to adapt to the application of various e-learning platforms, but also need to change their identities to "active questioners", and when there is a lack of external supervision, students' self-monitoring ability, self-feedback ability, and metacognitive ability are particularly important because effective education is active and interactive, not passive and isolated (Chickering & Gamson, 1987).

"The sudden switch to online learning requires an adaptation process and slow exploration of the functions of ZOOM." (CS-F-29)

In general, the online teaching model offers more possibilities for teaching and learning, and students gain a lot from this new teaching model.

"The online learning experience has improved my self-learning ability." (SS-F-21)

However, for some subjects, the online classroom needs to be further improved by combining various teaching strategies, teaching platforms, and online assessment tools.

"I have a good grasp of theoretical knowledge, but I lack opportunities to practice." (S-M-22)

"The learning effect of language subjects is not so good, especially in the speaking part." (T-F-14)

At the same time, the digital literacy of teachers and students also affects the teaching performance and students' participation in class to some extent.

"Many teachers are not well adapted to the online class model and are not skilled in the use of electronic devices." (SS-M-30)

With the popularity of online teaching and learning, proficiency in using online technology tools and designing more efficient and meaningful classroom activities with the help of international technological platforms will become essential competencies for future educators.

Online Learning Motivation

Motivation is the main source of students' learning behaviors and is divided into two main types: intrinsic and extrinsic motivation, and students' motivation has a significant impact on their attitude toward learning and their actual commitment to learning (Legault, 2006). Because the reward mechanism used in offline classrooms is more intuitive and convenient, it is easier to stimulate students' extrinsic motivation. In the online environment, students' intrinsic motivation becomes the main driving force for learning. We found that when students' intrinsic motivation is strong, namely, when their desire to learn is caused by

internal factors such as interest and desire to learn, they usually participate in learning activities more actively.

> *"The online learning model is more flexible compared to the traditional classroom, and I often look for knowledge that interests me outside of the textbook according to my preferences, rather than just relying on the teacher as in traditional teaching." (E-F-3)*

> *"There is also an increase in learning efficiency, and I can use my free time to use online resources to learn about subjects that interest me." (CS-F-29)*

In contrast, when students relatively lack intrinsic motivation, their cognitive behavior relies heavily on extrinsic motivation to drive their learning.

> *"I will replay the teacher's lesson once before the test, and sometimes I need to find information online." (E-M-11)*

> *"The teacher will take the reward mechanism in class, and usually I study more seriously at this time." (T-F-13)*

DISCUSSION

FIGURE 1
MODEL OF ONLINE CLASSROOM INTERACTIVITY AND LEARNING ENGAGEMENT IN MACAO UNIVERSITIES
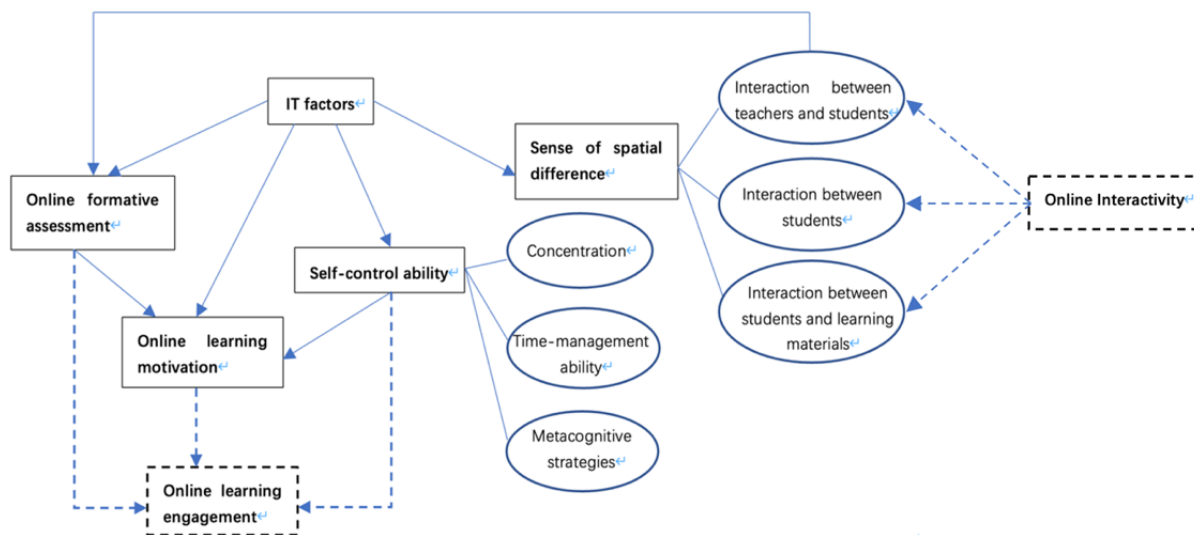
Based on the refined themes, a model of online classroom interactivity and learning engagement in Macao universities was constructed (Figure 1). This study found that the Internet is an important vehicle for online teaching and learning, and IT factors affect students' online learning motivation, self-control ability, and formative assessment of online classes. It also makes interpersonal interactions lack emotional engagement and there is a sense of spatial difference in interactions. Since online interactivity includes three dimensions: teacher-student interaction, student-student interaction, and student interaction with learning materials, the sense of spatial difference in interaction promotes students to efficiently search for learning materials and acquire more diverse knowledge outside of class; therefore, the sense of spatial

difference has two sides for students in the online training. In addition to IT factors, students' online learning motivation is also influenced by online formative assessment and self-control ability. On the one hand, the assessment itself could stimulate students' extrinsic motivation for online learning, while diverse forms of online assessment can promote teacher-student and student-student interaction and help students use online resources to collect relevant subject knowledge or knowledge of their interest outside of class, which can enhance their learning; on the other hand, students' self-control ability also affects their motivation and thus their engagement in learning, such as students' concentration in class, the time-management ability after class, and metacognitive strategies used in the online learning process that all of them will affect their engagement in learning behaviors. On the other hand, from the perspective of online formative assessment alone, the classroom interaction strategies used by the teacher in the classroom have an impact on online formative assessment, for example, the teacher's feedback to the students, the way they are evaluated, and the learning strategies adopted by the students in response to the formative assessment can also increase students' engagement in online learning and thus deepen their understanding of the content. In the following, this study will make further suggestions based on the distilled themes to address the poor online classroom interactivity and students' low learning engagement in the post-epidemic era.

At first, schools could regularly offer multiple training to improve teachers' IT skills, while teachers look for appropriate online teaching styles for their teaching context. According to the theoretical model constructed in this study, it is clear that IT factors are central to connecting the various themes and that teachers' IT literacy should not be neglected. At the school level:

"Schools can offer training to develop teachers' technological literacy." (SS-M-31)

At the teacher level:

"Online teaching content should be adapted rather than just moving the offline classroom directly online." (CS-M-41)

"Appropriate breaks in class can make students' learning more effective." (NS-M-37)

The adjustment of teaching style does not mean that every teaching session must be innovative, as long as the appropriate point in time and classroom activities leave moments that impress students is a successful transformation.

"Student concentration is related to the teacher's teaching style, and if different online training activities are designed or frequent questions are asked, there will be more communication between teachers and students." (CS-M-27)

"Teachers can add some feedback paths to the lesson and formative assessments to monitor student learning." (NS-M-37)

This is also consistent with the conclusion reached in Lackey's (2006) qualitative study that teachers' participation in relevant online instructional training is highly beneficial in their preparation for online instruction.

Secondly, students should improve their digital literacy. Online education is a process of teaching and learning, and in the multimedia era students also need to improve their IT digital literacy. However, it is also a challenge for students to establish effective interactions with teachers during online learning (Lackey, 2011). In Prior et al.'s study (2016), it was noted that students' digital literacy contributed significantly to self-efficacy. Since digital literacy involves an individual's ability to use information communications technology (ICT) and the Internet to achieve learning outcomes, higher digital literacy can better support students' online learning experience (Ng, 2012). Additionally, we found that individual differences in learners can lead to different online learning experiences. For instance, students with different learning

styles and personalities perceive online and face-to-face learning as each having their disruptive factors, and what one side perceives as a disadvantage is instead an advantage for the other side.

> *"Reduced interactivity but increased independent learning ability and self-discipline, and therefore improved performance." (SS-F-32)*

Thirdly, teachers should add diverse interactive sessions into online learning. Effective interaction can develop students' communicative skills, and even though the online mode of teaching conflicts with some forms of interaction in traditional offline classrooms, teachers can build on their strengths and avoid their weaknesses, to be more specific, actively using the online medium to enrich their teaching (Boling et al., 2012; Bernacki et al., 2012).

> *"Our teacher added a 'Share Your Experience' session at the end of the class, which was well received by the students, and the activities designed by the young teacher would be more interesting." (S-M-22)*

> *"When interaction is not strong, it would be more effective to use other web pages to assist teaching, such as creating a community where teachers and students post, comment, and like together should be fun." (E-F-25)*

This is similar to the findings of Phelps & Moro (2022), who found through a questionnaire survey of 174 college students who had used Kahoot! that web-based interactive polling could be considered an effective teaching strategy in blended learning. In addition, teachers should revisit their new roles and transform their interactive teaching strategies by incorporating the available e-learning resources.

CONCLUSIONS

The quality of online education faced in the post-epidemic era is an urgent issue that needs to be addressed, with poor classroom interaction and low engagement with student learning being representative of the problem. Our findings suggest that for higher education institutions in Macao, there is a correlation between interactivity in the online classroom and students' online learning engagement, where the information technology factor, is a top priority in online education, teachers and students should consciously improve their IT digital literacy in the future to make IT skills an effective tool for their teaching or learning. Since students are the main subjects of online learning, their self-control ability, and metacognitive strategies should be emphasized so that they can maintain a better learning state in the virtual learning environment. As for the spatial and temporal variability that occurs when interacting online, teachers can combine diverse online resources, teaching methods, and teaching styles to bring interpersonal communication closer. Nevertheless, it is difficult to come up with a specific and unique formulaic strategy for how to improve interactivity and student engagement in online training, as each online course involves different majors, teaching audiences, content, and teaching platforms. Therefore, teachers need to explore and practice their teaching models in real-world teaching environments.

LIMITATION AND FURTHER RESEARCH DIRECTION

First, the sample of this study is relatively limited and mainly concentrated in Macao. Although Macao is culturally diverse and the universities have different orientations, the research findings are somewhat generalizable. However, the number of universities is limited, and the main composition of the student population is not too extensive, so the external validity of the study needs to be strengthened. Future research can include colleges and universities in other regions or cities with multicultural backgrounds to expand the sample size and thus draw more convincing conclusions. On the other hand, this study only considered the students' perspectives. Although student perceptions are crucial for online learning, many

of the administrations and ideas from the instructional organizers were not available and did not echo the students' perspectives at the phenomenological level. For example, students believe that teachers can organize more interaction with students, but teachers may not be able to do so due to institutional or technical factors. Therefore, future research could consider adding teachers' perspectives to explore the multidimensional perceptions of online education in order to build a better theoretical model and draw research conclusions.

ACKNOWLEDGEMENT

REFERENCES

Abrami, P.C., Bernard, R.M., Bures, E.M., Borokhovski, E., & Tamim, R.M. (2011). Interaction in distance education and online learning: Using evidence and theory to improve practice. *Journal of Computing in Higher Education*, *23*(3), 82–103. https://doi.org/10.1007/978-1-4614-1785-9_4

Adnan, M., & Anwar, K. (2020). Online Learning amid the COVID-19 Pandemic: Students' Perspectives. *Online Submission*, *2*(1), 45–51. http://www.doi.org/10.33902/JPSP. 2020261309

Beldarrain, Y. (2006). Distance education trends: Integrating new technologies to foster student interaction and collaboration. *Distance Education*, *27*(2), 139–153. https://doi.org/10.1080/01587910600789498

Bernacki, M.L., Byrnes, J.P., & Cromley, J.G. (2012). The effects of achievement goals and self-regulated learning behaviors on reading comprehension in technology-enhanced learning environments. *Contemporary Educational Psychology*, *37*(2), 148–161. https://doi.org/10.1016/j.cedpsych.2011.12.001

Boling, E.C., Hough, M., Krinsky, H., Saleem, H., & Stevens, M. (2012). Cutting the distance in distance education: Perspectives on what promotes positive, online learning experiences. *The Internet and Higher Education*, *15*(2), 118–126. https://doi.org/10.1016/j.iheduc.2011.11.006

Boyatzis, R.E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Thousand Oaks, CA: Sage.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*, 77–101. https://doi.org/10.1191/1478088706qp063oa

Capper, J. (2001). E-learning growth and promise for the developing world. *TechKnowLogia*, *2*(2), 7–10. Retrieved July 20, 2022, from http://www.techknowlogia.org

Carvalho, C., Santos, N.N., António, R., & Martins, D.S.M. (2021). Supporting students' engagement with teachers' feedback: The role of students' school identification. *Educational Psychology*, *41*(7), 863–882. https://doi.org/10.1080/01443410.2020.1849564

Chickering, A.W., & Gamson, Z.F. (1987). Seven principles for good practice in undergraduate education. *American Association for Health Education Bulletin*, *39*(7), 3–6.

Childers, J.L., & Berner, R.T. (2000). General education issues, distance education practices: Building community and classroom interaction through the integration of curriculum, instructional design, and technology. *The Journal of General Education*, *49*(1), 53–65. Retrieved from http://www.jstor.org/stable/27797452

Das, R., & Meredith, D.P. (2021). Factors affecting effective online teaching transition in Asian universities during COVID-19. *Journal of University Teaching & Learning Practice*, *18*(8), 08. https://doi.org/10.53761/1.18.8.8

Douglas, T., James, A., Earwaker, L., Mather, C., & Murray, S. (2020). Online discussion boards: Improving practice and student engagement by harnessing facilitator perceptions. *Journal of University Teaching & Learning Practice*, *17*(3), 7. https://doi.org/10.53761/1.17.3.7

Fredricks, J.A., Blumenfeld, P.C., & Paris, A.H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, *74*(1), 59–109. https://doi.org/10.3102/00346543074001059

Gorbunovs, A., Kapenieks, A., & Cakula, S. (2016). Self-discipline as a key indicator to improve learning outcomes in e-learning environment. *Procedia-Social and Behavioral Sciences*, *231*, 256–262. https://doi.org/10.1016/j.sbspro.2016.09.100

Hannon, J., & D'Netto, B. (2007). Cultural diversity online: student engagement with learning technologies. *International Journal of Educational Management*, *21*(5), 418–432. https://doi.org/10.1108/09513540710760192

Heng, K., & Sol, K. (2021). Online learning during COVID-19: Key challenges and suggestions to enhance effectiveness. *Cambodian Journal of Educational Research*, *1*(1), 3–16. Retrieved July 15, 2022, from https://cambodianeducationforum.wordpress.com/2020/12/08/online-learning-during-covid-19-key-challenges-and-suggestions-to-enhance-effectiveness/

Kennewell, S., Tanner, H., Jones, S., & Beauchamp, G. (2008). Analysing the use of interactive technology to implement interactive teaching. *Journal of Computer Assisted Learning*, *24*(1), 61–73. https://doi.org/10.1111/j.1365-2729.2007.00244.x

Lackey, K. (2011). Faculty development: An analysis of current and effective training strategies for preparing faculty to teach online. *Online Journal of Distance Learning Administration*, *14*(4), 8. Retrieved July 15, 2022, from http://distance.westga.edu/~distance/ojdla/winter144/lackey144.html

Legault, L., Green-Demers, I., & Pelletier, L. (2006). Why do high school students lack motivation in the classroom? Toward an understanding of academic amotivation and the role of social support. *Journal of Educational Psychology*, *98*(3), 567–582. https://doi.org/10.1037/0022-0663.98.3.567

Liaw, S.S., & Huang, H.M. (2013). Perceived satisfaction, perceived usefulness and interactive learning environments as predictors to self-regulation in e-learning environments. *Computers & Education*, *60*(1), 14–24. https://doi.org/10.1016/j.compedu.2012.07.015

Means, B., Toyama, Y., Murphy, R., & Baki, M. (2013). The effectiveness of online and blended learning: A meta-analysis of the empirical literature. *Teachers College Record*, *115*(3), 1–47. https://doi.org/10.1177/016146811311500307

McIsaac, M.S., & Craft, E.H. (2003). Faculty development: Using distance education effectively in the classroom. *Computers in the Schools*, *20*(3), 41–49. https://doi.org/10.1300/J025v20n03_06

Mishra, L., & Raina, R.L. (2021). Online teaching effectiveness in higher education: Faculty perspectives in India. *Journal of University Teaching & Learning Practice*, *18*(8), 06. https://doi.org/10.53761/1.18.8.6

Muir, T., Douglas, T., & Trimble, A. (2020). Facilitation strategies for enhancing the learning and engagement of online students. *Journal of University Teaching & Learning Practice*, *17*(3). https://doi.org/10.53761/1.17.3.8

Ng, W. (2012). Can we teach digital natives digital literacy? *Communication Education*, *59*(3), 1065–1078. https://doi.org/10.1016/j.compedu.2012.04.016

Oviawe, J.I. (2020). Technical education lecturers' knowledge of students' engagement in application of interactive instructional strategies. *Journal of Technology and Humanities*, *1*(1), 1–10. https://doi.org/10.53797/jthkkss.v1i1.1.2020

Phelps, C., & Moro, C. (2022). Using live interactive polling to enable hands-on learning for both face-to-face and online students within hybrid-delivered courses. *Journal of University Teaching & Learning Practice*, *19*(3), 08. Retrieved from https://ro.uow.edu.au/jutlp/vol19/iss3/08

Prior, D.D., Mazanov, J., Meacheam, D., Heaslip, G., & Hanson, J. (2016). Attitude, digital literacy and self efficacy: Flow-on effects for online learning behavior. *The Internet and Higher Education*, *29*, 91–97. https://doi.org/10.1016/j.iheduc.2016.01.001

Revere, L., & Kovach, J.V. (2011). Online technologies for engaged learning: A meaningful synthesis for educators. *The Quarterly Review of Distance Education*, *12*(2), 113–124. Retrieved July 28,

2022, from https://www.proquest.com/scholarly-journals/online-technologies-engaged-learning-meaningful/docview/920291723/se-2

Senthamarai, S. (2018). Interactive teaching strategies. *Journal of Applied and Advanced Research*, *3*(1), S36–S38. https://dx.doi.org/10.21839/jaar.2018.v3S1.166

Shen, D., Cho, M.H., Tsai, C.L., & Marra, R. (2013). Unpacking online learning experiences: Online learning self-efficacy and learning satisfaction. *The Internet and Higher Education*, *19*, 10–17. https://doi.org/10.1016/j.iheduc.2013.04.001

Torcivia Prusko, P., Robinson, H., Kilgore, W., & Al-Freih, M. (2020). From Design to Impact: A Phenomenological Study of Human MOOC Participants' Learning and Implementation into Practice. *Online Learning*, *24*(2), 166–186. https://doi.org/10.24059/olj.v24i2.2003

Tsang, J.T., So, M.K., Chong, A.C., Lam, B.S., & Chu, A.M. (2021). Higher education during the pandemic: The predictive factors of learning effectiveness in COVID-19 online learning. *Education Sciences*, *11*(8), 446. https://doi.org/10.3390/educsci11080446

Vonderwell, S. (2003). An examination of asynchronous communication experiences and perspectives of students in an online course: A case study. *The Internet and Higher Education*, *6*(1), 77–90. https://doi.org/10.1016/S1096-7516(02)00164-1

Wagner, E.D. (1998). *Interaction Strategies for Online Training Designs*. Paper presented at the 14th Annual Conference on Distance Teaching & Learning, Madison, WI.

Wilson, S., Tan, S., Knox, M., Ong, A., Crawford, J., & Rudolph, J. (2020). Enabling cross-cultural student voice during COVID-19: A collective autoethnography. *Journal of University Teaching & Learning Practice*, *17*(5), 3. https://doi.org/10.53761/1.17.5.3

Yang, Y., & Cornelious, L.F. (2005). Preparing instructors for quality online instruction. *Online Journal of Distance Learning Administration*, *8*(1), 1–16. Retrieved July 15, 2022, from http://www.westga.edu/~distance/ojdla/spring81/yang81.htm

Zhang, H., Lam, J.F., & Su, S. (2021). A Qualitative Research on the Online Learning Experiences of College Students in Macao during the Pandemic. In *2021 5th International Conference on Education and E-Learning* (pp. 173–178). https://doi.org/10.1145/3502434.3502470

Zhang, H., Li, K., & Lam, J.F. (2022). A Phenomenological Study of Online Assessment Perceptions of Macao Higher Learning Institutions During the COVID-19 Pandemic: Dual Perspectives of Students and Instructors. In *2022 3rd International Conference on Education Development and Studies* (pp. 76–82). https://doi.org/10.1145/3528137.3528151