Towards a sustainable online peer learning model based on student’s perspectives

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Received: 3 January 2022 / Accepted: 24 May 2022 / Published online: 1 June 2022
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Abstract
The outbreak of the COVID-19 pandemic has fundamentally shifted learning from the traditional classroom approach to online learning. As such, this study used a revision centre as a case study to develop the factors that contribute to the theoretical framework of online peer learning in the higher education sector due to COVID-19. This study also explores the integrated effects of online peer learning on students and investigates whether advanced information technology creates new opportunities or additional burdens for students in adopting online peer learning environments. Descriptive statistical analysis, factor analysis, and correlation analysis were conducted on survey data gathered from 204 sub-degree students in Hong Kong. The results addressed four main factors developed from 39 variables: enhancement of learning ability, the attitude toward learning, motivation for learning, and interpersonal relationship which were closely associated. The study findings provide strategies and constructive recommendations for educators to develop a new online learning pedagogy, construct sustainable online peer learning, and effectively manage students’ online learning to meet the needs for post-COVID online education.

Keywords Peer learning · Online learning · Post-COVID · Higher education · Revision centre · Student perspectives

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1 Introduction

Since 2019, the coronavirus disease (COVID-19) has rapidly spread all around the world. Later, new virus variants (e.g., Alpha, Beta, Delta, Gamma, and Mu) emerged and transmitted rapidly in many countries where it became the leading variant. The coronavirus pandemic has affected 232.7 million people infected (Fig. 1), with almost 4.8 million deaths at the end of September 2021 (Fig. 2). The pandemic occurred in 206 countries crossing six main WHO geographical regions (i.e., Africa, Americas, Eastern Mediterranean, South-East Asia, Western Pacific, and Europe) (World Health Organization, 2021). To a certain extent, both specific vaccines and antiviral therapies hinder virus transmission. The outbreak of COVID-19 has been described as a black swan incident and linked to the economic event consequences of World War II (Nicola et al., 2020).

Consequently, the COVID-19 pandemic has created an adverse effect on international healthcare systems with a ripple impact on various sectors such as

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**Fig. 1** Number of confirmed cases of COVID-19, as of 30 September 2021. (World Health Organization, 2021)

**Fig. 2** Number of deaths of COVID-19, as of 30 September 2021. (World Health Organization, 2021)
tourism, medical, and education. To stop the spread of the virus, most countries implemented lock-down and quarantines policies (Maier et al., 2020). WHO also recommended preventive measures like school closures and physical distancing (World Health Organization, 2021). Accordingly, higher education institutions had no option but to shut down due to COVID-19 (Fig. 3). In the meantime, traditional face-to-face classes had no choice but to cancel and fundamentally shift to online learning immediately (Hamid et al., 2020). To diminish the effect of the academic advancement of students, online learning has become the temporary sole solution for this unexpected situation (Maier et al., 2020; Tang et al., 2021).

Sangrà et al. (2012) defined online learning as an approach to teaching and learning, representing all or part of the educational model applied, based on the use of electronic media and devices as tools for improving access to training, communication, and interaction and that facilitating the adoption of new ways of understanding and developing learning. During this period, the synchronous mode of online learning has been widely adopted to replace face-to-face teaching. The advantages of online learning and synchronous e-learning approaches are discovered and revisited by different educators (Chau et al., 2021). Dhawan (2020) identified that the online learning approach is more student-centric, innovative, and malleable. In particular, the emergence of new technology has resulted in various entirely new learning methods, such as knowledge construction analysis, ‘admire of lectures’, and ‘social network learning’, to name but a few. In the context of online learning, teaching strategies and interaction with instructors are becoming more flexible via flipped classrooms, blog education, active learning (Mo & Tang, 2017), hybrid learning (Tang et al., 2021), digital or virtual technologies (Tang et al., 2022), and blended learning (Singh & Thurman, 2019). Students were able

Fig. 3 Total duration of school closures, as of 30 September 2021 (UNESCO, 2021)
to understand the learning materials because the learning materials were delivered effectively (Indonesia, Media, 2021).

Moreover, students and teachers were agreed that online learning modalities had encouraged students to be self-directed learners during this ‘lockdown’ situation (Mukhtar et al., 2020). Nevertheless, adopting online learning to fully replace traditional face-to-face classrooms during school closures might be a huge challenge. The reality is that there are different obstacles (e.g., engagement, socioeconomic status, home location, students’ confidence in online learning culture and context) that occur while adopting online learning (Lau et al., 2021; Osorio-Saez et al., 2021). Maier et al. (2020) and Lau et al. (2021) found that the most significant barriers to conducting online learning include students’ lack of knowledge and skill in online learning use, limited access to devices and network speed. Faize and Nawaz (2020) argued that COVID-19 gives the perfect opportunity to improve the adoption of online learning. After modification, it is expected that those obstacles being alleviated, as well as online learning will be more meaningful, organized, and productive in the future.

Students undergoing the remarkable transition from secondary to tertiary education face unfolded challenges, and need to make adjustments in different areas including time management, assessment approaches, the scope of subjects, level of independence, degree of difficulty, and personality. Indeed, academic staff engaged in numerous non-teaching or administrative tasks and students studying in large class sizes lead to less availability to learners and are tremendous terrible challenges, possibly increasing student cohort separation and anonymity (Gannaway et al., 2018; Hanushek et al., 2003) and worse still, the COVID-19 pandemic imposes adverse impacts on their learning (i.e., learning ability, the attitude of learning, motivation for learning, and interpersonal relationship) in a higher education context. In doing so, the adoption of peer learning as a strategy to provide constructive learning support is investigated in this study. In higher education, peer learning has a considerable effect on deep learning and has been identified as an effective approach to fostering metacognition and higher-order thinking. There is an increasing trend of students using the peer learning style to modify a new learning paradigm (Hamad et al., 2020). Indeed, Hamad et al. (2020, p.5) remarked that peer learning reflects “to teach is to learn twice” and “you teach me, I teach you”. As such, peer learning fosters the smooth transition from face-to-face learning to online learning due to the COVID-19 pandemic (Tibingana-Ahimbisibwe et al., 2020) during campus closures in different stages over the past few years. To encourage students to proceed with learning in the time of campus closures, most higher education institutions started to give synchronous learning chances via an online peer learning approach (Youde, 2020).

Although online peer learning comprised of emerging technology, learning way, and philosophy of education has given students multiple choices, it brings a huge challenge simultaneously. Such diverse learning ways and learning environments provided by advanced information technology are new opportunities or burdens for students? What are the integrated effects of online peer learning on students?

Peer learning can be defined as “a one-to-one supportive relationship between the student and another person (e.g., senior student) of greater ability and experience”
Baud (2001) and Hanson et al. (2016) also identified peer learning as “students learning from and with each other in both formal and informal ways”; “a two-way, reciprocal learning activity which is mutually beneficial”; and “moving beyond independent to interdependent or mutual learning”. Strictly speaking, peer learning is a type of experience and knowledge sharing. The employment of learning and teaching strategies where students learn with and from each and everyone in the absence of instant interference with a teacher to obtain skills and knowledge (Boud, 1999; Gamlath, 2022). As such, Havnes et al. (2016) pointed out peer learning provided various benefits for students pertaining to developing time management skills, improving communication and interpersonal skills, better study skills, encouraging the adoption of creative thinking and critical thinking skills, improving psychological well-being, greater expectations of the subjects being learned, performing aspirations of academic attainment, and promoting lifelong learning. In accordance with Youde (2020), the peer learning mode can be undertaken by close peers who are the senior students without the engagement of teachers. Such senior students act as ‘peer mentors’ to facilitate junior learners in their smooth transition to college by giving academic support. The idea of peer learning is similar to collaborative or cooperative learning which commonly appeared in the higher education sector. In doing so, students form small groups to work together to strive for intended learning outcomes, find a solution for learning problems, and encourage collaborative learning by creating structured activities or tasks (Gershenfeld, 2014). In response to the COVID-19 pandemic, past research studies, such as by Bovermann et al. (2018); Geng et al. (2019); Ansari and Khan (2020) identified that collaborative learning approaches generate statistically significant outcomes and contribute to online learning.

Educators have produced numerous research papers raising the key issues of education in the time of the COVID-19 pandemic and beyond. The common topics are to investigate students’ readiness for the online learning context (Tang et al., 2021); students’ motivation in the online learning experience (Milovanović et al., 2020); the effect of COVID-19 on parental engagement and acceptance of online educational technology (Lau et al., 2021; Osorio-Saez et al., 2021); the influence of COVID-19 on students and teachers’ psychology, well-being, morale, and behaviour (Lashley et al., 2020; Verma et al., 2020; Wang & Zhao, 2020); and the challenges of teaching pedagogy and assessment in response to COVID-19 (Milovanović et al., 2020). Additionally, the notion of peer learning mainly concentrated on learners’ psychological well-being (Hanson et al., 2016); mapping a subject specialist pedagogy (Reid & Duke, 2015); the relationships between assessment and peer learning in online peer learning contexts (Altunay, 2017); and peer learning in the experience of international students (Idris et al., 2019). In doing so, the influence of the COVID-19 pandemic on online peer learning in the settings of higher education is under-researched. Even if the notion of peer learning is identified in past research studies, it only focused on a traditional theoretical framework of a community of inquiry (CoI) which a decreased the novelty (Lau et al., 2021). In addition, Bond (2020) carried out a systematic review of emergency remote education during the time of the COVID-19 pandemic, and the study summarized the online peer learning studies mainly concentrated on the perceptions and experiences of teachers,
parents, and students (aged 6–9 and aged 10–16). The methodological features were qualitative, quantitative non-experimental, and used the case studies approach. The study areas were from the US, UK, Indonesia, Germany, China, the Philippines, and Spain, and the areas of focus were general challenges, teacher digital competence, digital infrastructure, student well-being, and home/school connection. To fill the research gap, there is an urgent need for researchers to construct the theoretical framework of online peer learning in higher education during the COVID-19 pandemic via a survey research approach. To the best of the authors’ knowledge, the operation of the revision centre is not commonly found in higher education research, and as such, it may contribute to groundbreaking research in the field. Through the study, we give constructive recommendations and strategies for educators to establish a new online learning pedagogy, develop sustainable online peer learning, and effectively manage students’ online learning during the COVID-19 transition, as well as the needs in the post-COVID era.

This paper is divided into six main sections. The research background, objectives, and settings are given in the current section (i.e., Sect. 1). Section 2 provides an overview of peer learning and its associated concepts including enhancement of learning ability, the attitude toward learning, motivation for learning, and interpersonal relationship. After Sect. 2, participants, research context, and data collection processes are provided in Sect. 3. Then, a series of data analyses are conducted in Sect. 4. General discussion and conclusions are given in Sects. 5 and 6, respectively.

2 Literature review

2.1 Peer learning

Peer learning, also called peer instruction, is a kind of active learning strategy that supports learning. In general, peer learning helps students to have a better understanding of key concepts and promotes deeper engagement in learning outside the classroom (Hilsdon, 2014; Mazur, 1997). As the name suggests, peer learning involves people from similar background groupings who are not professional teachers helping each other. In other words, peer learning can be defined as the acquisition of knowledge and skill through active help and support among status equals or matched companions. Peer learning has been well-recognized as good practice since it can provide valuable learning experiences for students (Tibingana-Ahimisibwe et al., 2020; Topping, 2005).

In the face of the COVID-19 challenge, face-to-face learning has been wholly replaced by online learning. Although peer learning was developed for face-to-face learning, fortunately, peer learning is able to be adapted for campus-based, blended learning, and completely online learning (Nerantzi, 2020). Peer learning works properly in fully online learning when four essential features are taken into consideration: activities, choice, facilitator support, and community. These can redirect student attention and provide a more interactive learning experience for students (Nerantzi, 2017). To this end, virtual peer learning has been used to alleviate the challenges of higher education during the pandemic. Jeong et al. (2020) addressed
the needs of the School of Medicine of the University of Washington in designing and implementing a virtual peer teaching approach since the pandemic outbreak. As such, it was adopted using the format of students being taught by other students via videoconferencing. The study also summarized three potential benefits of virtual peer teaching. Firstly, students who were taught by peers have shown similar academic performance to the students who were taught by lecturers. As expected, a positive impact on student achievement would be generated. Secondly, peer instructors would be more available and flexible than teaching staff to facilitate the new problem-based online sessions that have taken the place of some clinical activities. Thirdly, peer learning can facilitate interaction within the class.

Although students faced unfolded pressure dealing with online learning during the pandemic, it was found that peer learning fostered students in combating the current stressful situation (Hamad et al., 2020). What is more, peer learning not only benefits the students but also the peer instructors. Being a peer instructor helps in being equipped with teaching and leadership skills, and it also leads to a better understanding of the subject while teaching the students. Therefore, higher education institutions even planned to continue adopting virtual peer teaching after the pandemic (Jeong et al., 2020). In a fully online learning setting, peer learning could successfully stimulate learning and create seamless active engagement which is now necessary due to the pandemic (Nerantzi, 2020).

Despite the peer learning being widely studied, most of the research considers that the peer learning model is composed of the students’ levels of responsibility, peer support, confidence, autonomy, and involvement (Hill et al., 2020; Markowski et al., 2021). Other research studies considered peer learning based on collaborative learning environments in terms of resources, peer support, and role definition. Dehghani et al. (2014) suggested that peer-assisted learning increases students’ confidence, and reduces their stress, providing positive outcomes for the development of student abilities and responsibilities. Despite there being no specific peer learning model commonly used in the higher institutes, we can generalize some features of peer-supported learning including the essential roles of interpersonal relationships among peers for providing support and communications, students’ attitudes toward learning and motivation that lead to the enhancement of learning ability. As such, we consider these are the key variables constituting the sustainable peer learning model for investigation. Details of each variable are explained as follows.

2.1.1 Enhancement of learning ability

In the context of the pandemic, it is a given that higher education institutions are adopting online learning. Worm and Jensen (2013) identified that online learning produced no impact on changing the learning ability of students. Instead, Nerantzi (2020) argued that peer learning enhanced the learning ability of students. To a certain extent, peer learning engaged different student disciplines inclusively. Accordingly, it integrated self-paced active learning seamlessly as an important part, as well as the support from peers leading to learner empowerment. In the study of peer instruction, the results showed that peer learning improved students’ exam performance and students’ retention of previously learned information. Therefore, peer
learning enhanced students’ learning ability by improving the mastery of the original learning material (Cortright et al., 2005; Gamlath, 2022). Another vital element that contributes to the enhancement of learning ability is adopting a peer-learning environment, in which students share their feedback and discuss improvement. In this way, students can learn from the study of errors (Donnelly et al., 2018). With the aid of peer learning, the learning ability of students is further increased at a certain level.

2.1.2 Attitude of learning

According to Hodgson et al. (2015), peer learning not only targets intellectual gains or formal academic achievement, but also attitudinal gains, which proves that peer learning causes a positive impact on the learning attitude of students. This statement can also be supported by data by Liu and Chen (2020), on the effects of peer learning on learning performance, motivation, and attitude. According to the results, it could identify students who participated in peer learning and achieved a significantly higher score for learning motivation and a more positive attitude than the students merely involved in face-to-face lectures. Apart from that, there was a study comparing the student’s attitude towards mathematics learning before and after participating in peer learning (Moliner & Alegre, 2022). The finding revealed that after adopting a peer learning strategy, students’ attitudes towards mathematics were improved. The role of attitudes towards learning is a vital factor in determining whether students succeed or fail. This phenomenon can be attributed to students who tend to learn more when they are interested in what they learn and also, they attained better results if they like what they learn. Researchers (e.g., Campit and Garin (2017)) also found that the changes in behaviour can be easily developed in the case of students who exhibited a positive attitude toward learning. Hence, the student attitude toward learning is positive through using the peer learning approach.

2.1.3 Motivation for learning

Increasing the learning motivation of students has been unfolding challenge for teachers. Especially during the pandemic, students were forced to fundamentally shift their study modes to online learning, and their motivation to study became more important than ever. The motivation of students is an essential criterion in learning, and it is also a vital part of student success (Afzal et al., 2010; Lau et al., 2018). In addition, peer learning engages diverse students inclusively, which can foster students cultivating active learning habits and encourages learning autonomy in a supportive environment. In other words, peer learning improves students capability of self-learning and provides support for them. Besides, as stated in the study of improving academic achievement and motivation through online peer learning, the results showed that online peer learning improved the academic achievement of students and facilitated their motivation (Nerantzi, 2020). Liu and Chen (2020) also pointed out that peer learning increased the motivation of students. In a study of the effects of peer learning on learning performance, motivation, and attitude, the results demonstrated that peer learning students exhibited a higher score in learning.
motivation than the students who only attained normal lectures. In the meantime, participants considered that peer learning is the most effective way of contributing to the enhancement of student overall learning. To this end, student motivation for self-learning has changed in the context of peer learning.

### 2.1.4 Interpersonal relationship

The word ‘peer’ in peer learning could be defined as a student in the same cohort or learning situation (Boud & Lee, 2005; Swayze & Jakeman, 2014). Precisely because of the same or similar learning background, the process of peer learning can strengthen the interpersonal relationships of students. There are numerous past research studies showed that peer learning not only created positive effects on learning outcomes, but also generated a beneficial influence on the social skills and self-esteem of students (Riese et al., 2012). The enhancement of social skills further increased their social status (Bell & Lygo-Baker, 2019; Topping, 2005). In general, peer learning includes mutual benefits and sharing of knowledge, ideas, and experience among participants. It more emphasizes the support and encouragement learners offer to each other, as much as the learning tasks rather than academic achievement (Boud, 1999; Tibingana-Ahimbisibwe et al., 2020). Moreover, peer learning hits targets of social and emotional gains, self-image and self-concept gains, which contribute to reducing the dropout rate. This would simultaneously yield gains in transferable social and communication skills and effective functioning. As such, it could make improvements in students’ self-esteem and knowledge in their subject area (Lau et al., 2021; Topping, 2005). Additionally, peer learning is recognized as a systematic cooperative learning method that is supported by social interdependence theory, which has been demonstrated to offer cognitive and emotional advantages (Casey & Goodyear, 2015). The peer effects produced during peer learning are ‘institutional’ and ‘social’ and are considered more likely to operate in the ambient environment (Parr & Townsend, 2002; Riese et al., 2012). Through the adoption of peer learning, the interpersonal relationships with other students have changed, and the needs and social statuses have changed as well.

### 3 Methodology

A peer-learning environment generates a new way to help students conduct self-learning by utilizing the power of the internet. It is also an integrated learning platform composed of tools, services, people, and resources. Since the outbreak of COVID-19 in 2020, students have been subjected to long periods of home isolation due to the government’s lockdown policy. In such circumstances, the total number of student groups using the peer learning approach for self-study has been at rising trends. Peer learning is now being progressively adopted by Chinese students (Miao et al., 2017; Yu & Lee, 2016). As this field of research is still in the development stage, our research study is based on the existing literature, combined with the results of questionnaires. A series of statistical analyse on the integrated impact
of peer learning on students by various factors was conducted, and the formation mechanism proposed.

3.1 Research context—revision centre

The study is illustrated by one self-financing institution that established a revision centre starting in 2016/17 academic year. The Centre is intended to provide a meeting place to encourage face-to-face peer learning opportunities during academic semesters. Peer mentees refer to students enrolled in higher diploma and associate degree programmes in a business discipline, especially weaker performing students, and first-year students. Quality graduates who obtained outstanding academic performance and have good personality traits are employed as peer mentors to provide excellent learning support for peer mentees. The peer mentees and peer mentors were engaging in peer learning via common online communication tools such as WhatsApp and WeChat.

3.2 Ethics

The research studies comprising human participants were examined and ratified by the local University, after submitting an ethics review checklist of human issues during the rigorous ethical approval process. During the study, information sheets and consent forms were given to the survey respondents for their agreement. The consent form highlights the information collected from this research would possibly be published and for future development.

3.3 Data collection

The research team circulated an online questionnaire to the sub-degree students in 2020 using a simple random sampling approach. Ethical approval was granted by the university in advance, and the confidentiality requirement was that, all the respondents’ particulars would not be disclosed, and their answers were only considered for academic purposes. In order to determine the effects of peer learning, only those students who participated in the revision center in the proceeding six months and received mentoring from their peers were included in this study. Those students who do not fulfill this requirement were excluded from this study and their responses were considered invalid.

3.4 Research design

A total of 39 questions were designed in the first part of the questionnaire based on the relevant literature (Campit & Garin, 2017; Casey & Goodyear, 2015; Donnelly et al., 2018; Liu & Chen, 2020; Miao et al., 2017; Nerantzi, 2020; Yu & Lee, 2016). The questions were set from four main different perspectives, covering the key determining factors of peer learning on students. The four different perspectives were (1) enhancement of learning ability; (2) attitude of learning; (3) motivation for
learning; and (4) interpersonal relationships. A five-point Likert-scale was adopted in this questionnaire, from strongly disagree to strongly agree, 1 to 5 points respectively. The second part of this questionnaire specifically investigated the interviewees’ demographic information (i.e., gender and age). The gender options were male and female (i.e., scoring 0 and 1). The options for age were below 18 years old and 18 to 20 years old (i.e., scoring 0 and 1).

To identify the appropriate research design, the measurement scale, content, and questions, opinions from external researchers, educators, teacher associations, graduates, and industry practitioners were received. Such input, it can enhance the validity of the content and confirm the precision of the survey instruments. Importantly, face validity (Lau et al., 2021) was performed to ensure the questionnaire entirely excluded fuzzy wordings and duplicate sentences or wordings. Before conducting formal data collection, a pilot test was performed to collect preliminary feedback and comments to ensure the quality of the questionnaire in advance. Finally, the questionnaire was reviewed by the research team to ensure the flow of the questions in the survey was appropriate.

3.5 Statistical analysis

After collecting feedback from the target students, statistical analysis was performed to validate the data and determine correlations of each component in the research model. SPSS statistical software was adopted in this study in order to conduct factor analysis and cluster analysis in the first part, and descriptive analysis in the second part. Principal Components Analysis (PCA) was used to identify the latent factors being examined by the survey questions. Factor loading values over 0.4 were used in this study. Regarding the model reliability, Nunnally (1967) proposed that the values of Cronbach’s alpha reliability should be at least 0.6 as a reference value to calculate the internal consistency in a research study.

4 Results

4.1 Descriptive statistical analysis on demographic variable

The questionnaires were distributed to 247 target students from the business disciplines. Finally, 204 valid questionnaires were collected which represents a high response rate of 82.6%. In the survey population, there were 85 males in total, accounting for 41.7%, and are 119 females in total, contributing to 58.3%. The survey respondents were aged between 18 and 20 years old, while the level of education was mainly from the sub-degree high diploma programmes and associate degrees.

4.2 Factor analysis

In the study, factor analysis was conducted on the 39 questions in the first part of the questionnaire. Interestingly, there were no inappropriate questions in the
questionnaire, hence, all 39 questions were kept. According to factor analysis, the KMO value was used for comparing the correlation between variables and the coefficient of partial correlation. The KMO value ranged from 0 to 1, and a larger value represents a higher value suitable for conducting the factor analysis. In addition, Bartlett sphericity tests the level of correlation of each variable and factor analysis can be conducted when the p-value is less than 0.05. As shown in Table 1, the value of KMO was 0.958, which indicated that the partial correlation between variables was very strong, which is very suitable for carrying out PCA. The Bartlett test demonstrated that p = 0.000 < 0.01. It was proven that the variables were not independent, were able to extract the main components, and were suitable for conducting factor analysis.

Table 2 shows the results of adopting PCA to analyze the 39 variables. The results have determined that the eigenvalues of the first factor were 22.304 and have explained 57.19% of the total variance of the model. The eigenvalues of the first 4 factors were greater than 1. Yet, according to the analysis, the cumulative variance contribution rate of the first 4 factors was 69.43%. The results identified that 4 factors can be extracted to explain the factors of online peer learning model.

Based on the screen plot (Fig. 4), the study confirmed that the number of the extracted factors in which online peer learning affects students is 4. The name and its meaning are interpreted as follows:

- Factor 1—Enhancement of Learning Ability (ELA): the learning ability of students is enhanced at a certain level through the adoption of online peer learning.
- Factor 2—Attitude of Learning (AL): the students’ attitude toward learning has changed with the aid of online peer learning.
- Factor 3 – Motivation for Learning (ML): the students’ motivation for self-learning has changed with the use of online peer learning.

| Component | Eigenvalue | Initial Eigenvalue and Percentage of Variance | Accumulation (%) | Total Loading Squares Extracted and Percentage of Variance | Accumulation (%) |
|-----------|------------|---------------------------------------------|------------------|-------------------------------------------------------------|------------------|
| 1         | 22.304     | 57.189                                      | 57.189           | 22.304                                                      | 57.189           |
| 2         | 2.170      | 5.564                                       | 62.754           | 2.170                                                       | 5.564            |
| 3         | 1.432      | 3.673                                       | 66.426           | 1.432                                                       | 3.673            |
| 4         | 1.170      | 3.001                                       | 69.427           | 1.170                                                       | 3.001            |

**P < 0.01**

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Table 1 KMO and Bartlett test

|                         | The number of valid KMO sampling | 0.958 |
|-------------------------|----------------------------------|-------|
| Bartlett sphericity test| Similar Chi-square                | 7730.884 |
|                         | Degree of freedom                 | 741** |

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Table 2 Explanation of total variance

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• Factor 4—Interpersonal Relationship (IR): through the employment of online peer learning, the relationship with other students who also use online peer learning has changed, and the needs and social status have changed as well.

The factor loadings for each question were also determined, and for the factor ELA, the loadings were 0.514 to 0.772. The factor loadings for AL, ML, and IR were 0.522 to 0.825, 0.475 to 0.68, and 0.547 to 0.693 respectively. It indicated that all the questions were appropriate in this study.

4.3 Reliability, validity, and correlation analysis

In addition, we adopted Cronbach’s coefficient to perform reliability testing of the questionnaire. The alpha coefficient of the total questionnaire was 0.932, which represents excellent reliability of the entire model. Most of the factors achieved very good reliability, except the factor motivation of learning, which had a value of was 0.779, which nevertheless was larger than 0.7 indicating a satisfactory result. The overall questionnaires results and the details of the internal consistency reliability are illustrated in Table 3.

The construct reliability (CR) and the average variance extracted values (AVE) were determined to investigate the validity of the study. Lastly, the correlation between each factor was determined to investigate the relationship of these factors and provide useful information on further improvement of the revision center. The results are illustrated in Table 4. Based on the results, it was found that all the values of CR were larger than 0.7, but the AVE was smaller than 0.5. However, as the CR was > 0.6, these factors were still marginally valid in the investigation. The correlations of the measured factors were 0.717 to 0.854, indicating high Pearson correlations between each other. The correlations were significant at the level of 0.01.
General discussion

The study found that ELA, AL, ML, and IR are closely interrelated. These four key factors generate the theoretical framework to develop online peer learning in the higher education sector during the COVID-19 pandemic. The four factors construct a theoretical framework that not only considers the student perspectives, but also the COVID-19 pandemic situation. Accordingly, these four interrelated factors can give a piece of constructive advice for educators to optimize orientation, learning activities, teaching pedagogies, and choice of suitable technology tools during the COVID-19 transition period. It can also explore how the decisions interface with the levels of collaboration between students. Nevertheless, advanced information technology creates new opportunities for students to adopt online peer learning environments. In addition, past research studies relevant to online peer learning have shown that a positive student learning experience is vital to successful learning (Sakulwichitsintu et al., 2018). In response, our proposed four main factors clearly define student-learning experiences. In Fig. 5, we illustrate a theoretical framework of online learning.

In general, all students transfer from secondary school to tertiary education, as well as change from a traditional classroom to an online learning approach during COVID-19 pandemic. Such fundamental shifts generate an unexpected learning difficulty in coping with new learning contexts (Lau et al., 2021; Tang et al., 2021). Following Lau et al., (2022, p.12), online peer learning can reinforce some elements of the ‘TRANSFER framework’, namely academic support, networking, and resources. This is crucial to facilitate the students’ smooth transition and enhances transfer students’ belongingness or retention in their respective universities during the COVID-19 crisis.

| Table 3 | Reliability analysis |
| Factors | Mean (SD) | Consistency reliability |
| Overall | 0 932 |
| ELA | 4.02 (0.661) | 0.882 |
| IR | 3.80 (0.744) | 0.843 |
| AL | 4.01 (0.677) | 0.869 |
| ML | 3.84 (0.738) | 0.779 |

| Table 4 | Construct reliability, average variance extracted values, and correlations between each factor |
| Factor | No. of Items | CR | AVE | 1 | 2 | 3 | 4 |
| ELA | 15 | 0.899 | 0.377 | 0.614^ |
| IR | 11 | 0.874 | 0.392 | 0.803** | 0.626^ |
| AL | 9 | 0.834 | 0.362 | 0.854** | 0.820** | 0.602^ |
| ML | 4 | 0.736 | 0.412 | 0.762** | 0.717** | 0.721** | 0.642^ |

^square root of AVE. **p < 0.01

5 General discussion

The study found that ELA, AL, ML, and IR are closely interrelated. These four key factors generate the theoretical framework to develop online peer learning in the higher education sector during the COVID-19 pandemic. The four factors construct a theoretical framework that not only considers the student perspectives, but also the COVID-19 pandemic situation. Accordingly, these four interrelated factors can give a piece of constructive advice for educators to optimize orientation, learning activities, teaching pedagogies, and choice of suitable technology tools during the COVID-19 transition period. It can also explore how the decisions interface with the levels of collaboration between students. Nevertheless, advanced information technology creates new opportunities for students to adopt online peer learning environments. In addition, past research studies relevant to online peer learning have shown that a positive student learning experience is vital to successful learning (Sakulwichitsintu et al., 2018). In response, our proposed four main factors clearly define student-learning experiences. In Fig. 5, we illustrate a theoretical framework of online learning.

In general, all students transfer from secondary school to tertiary education, as well as change from a traditional classroom to an online learning approach during COVID-19 pandemic. Such fundamental shifts generate an unexpected learning difficulty in coping with new learning contexts (Lau et al., 2021; Tang et al., 2021). Following Lau et al., (2022, p.12), online peer learning can reinforce some elements of the ‘TRANSFER framework’, namely academic support, networking, and resources. This is crucial to facilitate the students’ smooth transition and enhances transfer students’ belongingness or retention in their respective universities during the COVID-19 crisis.
**ELA**—The peer mentors share valuable learning experiences (e.g., subject selection and online learning skills) with existing students. Also, online peer learning improves the students’ soft skills (e.g., problem-solving, communication, and critical thinking) and reinforces or strengthens the students’ background knowledge of the discipline and sophisticated concepts via additional exercises and professional guidance (Lau et al., 2018). In doing so, this not only enhances students learning ability of hard, applied disciplines, but also ensures the smooth articulation of students with maximum credit transfer (Hammond et al., 2010; Lau et al., 2022).

**AL**—Traditionally, the education system adopts one-way learning and teaching. This scenario is so-called ‘stuffing the duck education’ (Baskir, 2015). As such, the deeply-rooted concept provides negative impacts on student learning such as dependency and passive learning attitudes. In practice, online peer learning used small groups to participate with students and deepen learning in a new online learning setting. Peer mentees and peer mentors study together in small groups of typically 8 members to support each other to think critically and recap knowledge or concepts via discussions (Klinge, 2015). To a certain extent, students’ learning attitudes are shifted from passive to active and from dependent to independent via the online peer learning approach.

**ML**—Generally, most sub-degree students consider taking an associate degree or a higher diploma programme as a stepping stone for further university study. Their motivation for engaging in online peer learning is because peer mentors create role models via their impressive and successful stories. In the short term, the students may enrich their study skills in achieving outstanding academic performance or excellent progress. Indeed, the peer mentors provide useful guidance and valuable insights into further studies in desirable programs via non-JUPAS applications (Lau et al., 2018). In a long term, students seek professional advice from peer mentors on how to create a successful career path and obtain a professional qualification in the maritime logistics
industry in response to post COVID-19 era. Furthermore, online peer learning generates a new, innovative, and interactive learning approach which allows students to enjoy flexible learning in terms of time and place restrictions via various social media tools like WhatsApp, WeChat, Microsoft Teams, and Instagram (Gamlath, 2022).

IR – The revision centre selects peer mentors not only for their academic achievement, but also their personalities (i.e., caring, friendly, harmonious, generous, and diligent) and age. Peer mentors and peer mentees generate peer influence and contribute to the association between ability tracking and peer-to-peer teaching. Both peer mentors and peer mentees are Gen Z who rely on peers to build up team spirit and support each other in learning difficulties. In particular, COVID-19 has rapidly changed their social and educational experiences (Osorio-Saez et al., 2021). School closures, social distancing, and ‘lockdown’ policy lead to this generation to perceive being isolated in the community. Through online peer learning, peer mentors and peer mentees may create close ties to maintain mental health and establish friendships in a virtual social network (Tang et al., 2020).

6 Conclusions

Higher education institutions have undergone unprecedented challenges and fundamental shifts in response to the COVID-19 pandemic. To minimize the spread of the virus, the government has implemented a series of stringent measures including a lockdown policy, social distancing, and campus closure to name but a few. In this situation, online learning has become a new, innovative teaching pedagogy in this time of the COVID-19 crisis. Nevertheless, numerous educators and researchers have indicated that online learning may bring adverse impacts on students’ learning experience. It is revealed that the first-year students and weaker performing students suffer greatly without good learning support. Up to now, the educators may have little knowledge of applying best practice online learning support to intensive online environments. Online peer-learning is identified as one of the effective online learning approaches during the COVID-19 pandemic. As such, our study illustrates a typical example of a revision centre in recognizing the ways to optimize online peer learning. The study found that students’ learning ability, attitude toward learning, motivation for learning, and interpersonal relationships are four interrelated factors for creating a theoretical framework of online peer learning. Indeed, the study investigates advanced information technology that generates new opportunities for students to adopt online peer learning contexts and improves the integrated impacts of online peer learning. Through online peer learning, students expect that it can help maintain their academic progress in the second year of study and then achieve smooth articulation into UGC-funded degree programmes. In particular, the study used the maritime logistics subjects to explore the need for online learning support due to COVID-19. Generally speaking, maritime logistics subjects are discipline-specific which not only improve students’ fundamental discipline-specific knowledge, but also equip students with professional social skills. It reflects that there is an increasing number of
employers (e.g., government and corporations) who prefer to recruit workers who are more skilled and highly motivated (Lau et al., 2018). In other words, the use of online peer learning is considered a good vehicle for sustaining the development of discipline-specific subjects and enlarging the scope of professional education.

This study has created a foundation work for the further research. However, there are some pitfalls to the research. In the beginning, this study only focused on the business discipline. As such, the study may take into account students of different disciplines, for instance, engineering, languages, and social sciences. As expected, this may generalize the research findings and reinforce the understanding of similarities and differences in online peer learning in each academic discipline. In addition, the use of self-reported data is determined by the survey respondents. Sometimes, the survey respondents maybe not be willing to report actual human behaviour because of insufficient relevant knowledge or particular consequences. Moreover, the study used a revision centre (i.e., private study groups) as a real case to investigate the impacts of the COVID-19 pandemic on online peer learning in the settings of higher education. In doing so, the research team may consider other models of peer learning like discussion seminars, laboratory work, collaborative projects, service-learning activities, and workplace mentoring to produce a comparative study and create a constructive theoretical online peer learning framework in forthcoming studies. Finally, the data were mainly gathered from students. In the future, the study may consider qualitative data from different stakeholders such as educators, policymakers, and industrial practitioners through semi-structured, in-depth interviews to produce thorough data and obtain wider viewpoints for deep analysis.

Acknowledgements The authors would like to acknowledge the support of the Macau Higher Education Fund (Ref.: TETCITYU-2020-04) for this research.

Funding This research was funded by the Macau Higher Education Fund (Ref.: TETCITYU-2020–04).

Data availability The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to research participant privacy.

Declarations

Conflicts of interest The authors declare no conflict of interest.

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