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Student learning performance in online collaborative learning

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Abstract
Online collaborative learning (OCL) has received significant attention, but the ultimate goal of adopting OCL is neglected, especially in higher education context. To bridge the research gap, the present study applied OCL theory integrating with cognitive development to evaluate the effectiveness of student learning performance through OCL. To our knowledge, this is the first study to operationalize the constructs of idea generating, idea organizing and intellectual convergence of the OCL process developed by Harasim (2012)'s framework adapted from knowledge management perspectives. A sample of 373 respondents was collected from Sojump (http://www.sojump.com) using judgmental sampling method. Structural Equation Modelling (SEM) is employed to analyze the research model. All the hypotheses are supported in the model and the findings of this study provide a comprehensively understanding about student learning performance in the OCL process. The study illustrates that there are significant relationships among online collaborative tools, collaboration with peers, student engagement, OCL activities, and student learning performance. The study concludes that OCL promotes student engagement and teacher involvement to facilitate group discussion, ultimately strengthen student learning performance.

Keywords Online collaborative learning · Student engagement · Student learning performance · Knowledge management · Structural equation modelling

1 Introduction

With the rapid growth of information technologies to support teaching and learning activities, adopting innovative technology enhances better learning outcomes of learners (Ofori et al., 2020). Collaborative learning (CL) is a new trend of learning

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involving students to participate and interact from their group members. Students interact in a learning environment and learn actively through forming questions, discussing and sharing ideas, making collective decisions and reflecting on their thinking and experiences (Al-Samarraie & Saeed, 2018). The use of innovative technology encourages learners to explore different learning settings and environments (e.g. online environments) to achieve collaborative learning purposes. Examples of online environments for CL that have been adopted by educational institutions include computer-supported collaborative learning (CSCL) and online collaborative learning (OCL). In higher education context, OCL has constituted a new domain of learning in online education, which promotes seamless learning, higher social engagement level among learners, and higher order thinking skills (Malik & Fatima, 2017; Park et al., 2019; Yadegaridehkordi et al., 2019). OCL moves collaborative learning from traditional learning environment (i.e. face-to-face) to online learning environment, allowing students with different performance level work together in small groups and learn from each other through collaboration among students and teachers. According to Qureshi et al. (2021), OCL has been widely used as an effective learning model to enhance students' academic performance.

Whether or not students are adaptive to the OCL environment depends on some tangible and intangible attributes, such as appropriate technology, collaboration learning with peers, social engagement, etc. Most previous studies used Technology Acceptance Model (TAM) extensively to investigate learners' behavioral intention to adopt OCL (Yadegaridehkordi et al., 2019; Qureshi et al., 2021), or online technologies (Balouchi and Samad, 2021), or teachers' behavioral intention to use technology in future teaching (Gurer, 2021) in higher education context, neglecting the ultimate goal of adopting OCL or online learning (i.e. enhance learners' learning performance/achievement). To bridge the research gap, the present study applied OCL theory integrating with cognitive development (e.g. interaction with peers and student engagement) to evaluate the effectiveness of student learning outcomes of learners through online collaborative learning.

Previous empirical studies examined tangible and intangible factors affecting OCL, including technology characteristics, perceived ease of use, perceived usefulness, social engagement, etc. (Yadegaridehkordi et al., 2019; Hernández-Sellés et al., 2019). Of the factors that influence OCL, literature demonstrated that social interaction and engagement are the key factor (Qureshi et al., 2021; Molinillo et al., 2018; Hrastinski, 2008). In a learning environment, social interaction includes interaction with peers (e.g. classmates, groupmates) and interaction with instructor. Through the interaction with peers, students are not only motivated to learn but also engaged themselves in participating and interchanging ideas (i.e. ideas generating) among their groupmates and instructors (Hrastinski, 2008). Therefore, interaction with peers as well as student engagement are considered as playing a fundamental role in OCL. In addition to social interaction and student engagement, it is essential to examine the effectiveness of OCL (i.e. generating ideas, organizing ideas and intellectual convergence) as it helps in explaining how student learning performance is influenced by OCL characteristics. Within the context of OCL, it is also significant to consider the effect of online collaborative tools (e.g. Zoom, Tencent Meeting, Microsoft Teams, Google Meet, etc.) which is useful to explain how the characteristics of appropriate technology predict student engagement (Bonfiglio-Pavisich, 2018). Therefore, the objective of this study is to examine the impact of technology characteristics (i.e. online collaborative tools), social interaction (i.e. collaboration with peers), student engagement on student learning performance by incorporating OCL theory (i.e. idea generating, idea organizing and intellectual convergence). A research model was developed (Fig. 1) to analyze the relationships.

The structure of this paper is organized into 3 sections. First, the theoretical background, hypothesis development and research models are discussed. Second, detailed research methods, data, and results are presented. Lastly, the implications and limitations of this study are included.

2 Research model and hypotheses development

2.1 Student engagement

Student engagement and learning performance in higher education context have received considerable attention over the past decades in Asia (Luo et al., 2021). Student engagement refers to "the extent of students' involvement and active participation in learning activities" (Cole & Chan, 1994, p.259). Promoting student engagement is important in the learning process which motivates students to practice higher level critical thinking skills, promoting meaningful learning experiences (Heflin et al. 2017). There are numerous studies linking student engagement and student learning performance, include academic achievement and student learning outcomes (Bai et al., 2021; Zhoc et al., 2019). There are different approaches to student engagement, and behavioral approach is the most common approach used in higher education literature. According to Ko et al. (2016), the behavioral approach of student engagement can be measured by surveys. Student engagement is a crucial component in successful online collaborative learning. Several studies have tried to examine the underlying mechanisms to link student engagement and student learning performance in order to identify the influential factors and the role institutions play in motivating student engagement, leading to desired learning performance.

2.2 Online collaborative tools

Online learning needs more detailed instruction compared with the face-to-face instruction course and distance learning shall depend on the AT (Sun, 2016). Sukendro et al. (2020) and Balouchi and Samad (2021) contended that online learning technology can significantly increase online learning performance, and it effectively increases knowledge exploration during distancing learning, through increasing of motivation to the learner to stay active and access materials everywhere and anytime. Consequently, the learner can promote fluent and real-time interaction with the instructors, which boosts the idea-generating that improves cognitive presence where knowledge occurs in higher education (Borge et al., 2018). For example, Hernández-Sellés et al. (2019) outlined that the use of Computer-Supported Collaborative Learning (CSCL) can improve the learning process in the higher education level by online collaborative tools such as online discussion forum, which helps the group members to collaborate and fluid exchange of information. Appropriate technology would benefit learner to establish an inter-personal connection with classmates online and receive better learning outcomes (Ornellas & Muñoz, 2014). Based on the above empirical insights and theoretical arguments to the context of online learning, we put forward the following hypothesis:

H1: Online collaborative tools positively influence student engagement.

2.3 Collaboration with peers

Qureshi et al. (2021) advocated that the development of classrooms for active learning is emphasizing the learner's involvement and engagement during the learning time in higher educational institutes. Siau et al. (2006) pointed out that successful learning outcomes rely on online collaborative learning through optimum interaction with peers but not study independently in the online environment. The linkage among students could improve the students' interest and motivate them to explore various knowledge in depth and enrich the learning outcomes (Kuo et al., 2014; Sarwar et al., 2019). According to Shapiro et al. (2017), interactivity can strengthen the linkage among the students and encourage them to share academic ideas and information, the collaboration with peers becomes an important element of academic progress. In online settings, students would discuss with their classmates or peers in smaller groups by creating a number of virtual breakout rooms (e.g. Zoom breakout rooms, Tencent Meeting breakout rooms), motivating students to share and exchange ideas during small-group discussion (Sadler et al., 2020). Therefore, the students can learn in collaborative settings with full emotional support and intragroup interaction, as well as develop problem-solving skills. Accordingly, we hypothesis the following:

H2: Collaborative with peers positively influences student engagement.

2.4 Online Collaborative Learning (OCL)

Comparing to the traditional classroom setting, online collaborative learning proposed by Harasim is focusing on the transformation of learning environments with facilities of internet, allowing students to foster a certain level of collaboration and formulate a higher standard of knowledge building (Harasim, 2012; Ku et al., 2013). OCL intends to use the power of networks and embed them into learning through large-scale networked education (Picciano, 2017). At the same time, OCL encourages the student to learn collaboratively through problem-solving, as well as idea discourse, while the instructor is a learning community leader. Therefore, OCL is suitable to various educational environments and becomes more important among online education settings, there are three existing phases of knowledge building that need to be accomplished online as follows:

2.5 Idea generating (IG)

IG is the very first phase that encourages the student to have the brainstorming process online. Throughout the whole brainstorming duration with communication with the instructor, divergent ideas can be allocated (Kumi-Yeboah, 2018). In addition, the students can generate critical ideas by talking and writing. The students and instructors are able to share the proposed ideas and gather information and make a consensus about the first layer of the idea (DiPasquale, 2017). IG demonstrates a democratic process of various perspectives among the classmates based on a diversity of observations (Breen, 2015). Ismail and Kinchin (2019) concluded that there is a successful case of online collaborative learning at Egyptian Higher Education system, the result showed that the virtual classroom offers opportunities for the student to learn outside the standard brick-and-mortar classroom to receive the higher ability of IG, the instructor also aware the pedagogical concerns about IG. Therefore, this study put forward the following hypothesis:

H3a: Student engagement positively influences students' idea generation within the context of OCL.

2.6 Idea organizing (IO)

Once the ideas have been set up through IG, the IO would be organized through interactions with various stakeholders, i.e., instructors, classmates. This is the phase of a leaner who compares, analyzes, and categorized ideas through online discussion and in-depth investigation (Mnkandla & Minnar, 2017). Rahman et al. (2021) pointed out that the learner should have direct instructions from the instructors, so they can make the courses content more understandable and clarify what ideas should be conducted accurately. It is important to note that the learner-instructor interactions play an important role during IO stage. The frequency of learners asks questions to the instructors through electronic means, such as discussion boards, online conferencing, and email would form community of inquiry that allows students to organize and further improve the academic ideas (Garrison et al., 2000; Kumi-Yeboah, 2018; Rahman et al., 2021). Therefore, the instructors' reply to the sufficient answer in a timely fashion would also improve the student learning outcome as much as possible, taking an initiative role in constructing knowledge with the involvement of students (Blieck et al., 2019). Thus, we put the following hypothesis:

H3b: Student engagement positively influences students' idea organization within the context of OCL.

2.7 Intellectual convergence (IC)

Intellectual convergence refers to the phase where the learner processes the intellectual synthesis about the course content and ensures the consensus occurs for the whole learning outcomes (Picciano, 2017). IC also pushing the learner to reflect on the ideas generated at the beginning and adjust their possible new ideas at the later stages (Caballe et al., 2010). OCL advocates that learning outcomes can be improved through agreeing with others' opinions from disagreeing. Through IC, the discussion becomes more meaningful among the students, joint pieces of work or other group work would be able to improve the views of the students, so they can present appropriate critical thinking on specific issues (Blieck et al., 2019). Eventually, the student builds a healthy and positive instructional environment with the peers and the instructor, so they shall have an efficient learning perspective and strive for greater academic achievements (Aldholay et al., 2018). Therefore, this study put forward the following hypothesis:

H3c: Student engagement positively influences students' idea convergence within the context of OCL.

On the other hand, OCL supplements the learners by providing a platform that allows the instructor to support and motivate the learner to work together for creating new knowledge and innovation through collaboration (Mehta et al., 2017). Through three essential phases of OCL (i.e., idea-generating (IG), idea organizing (IO), intellectual convergence (IC)), it can ensure the students are following closely to the standards and expected learning outcomes of the subject's domain integrated with the learning cycle. At the same time, various factors such as appropriate technology, collaboration with peers are affecting online collaborative learning and form the community of inquiry that manifests interactions between learners and instructors (Picciano, 2017). For this, we have proposed the following:

H4a: Students' idea generation positively influences students' idea organization during the OCL process.

H4b: Students' idea organization positively influences students' idea convergence.

2.8 Student Learning Performance

Tzafilkou et al. (2021) emphasized that learnability is directly influencing student learning performance and student learning outcomes. Since learnability is the crucial precondition of a learner to gain knowledge improve, the learners still need to attend the lectures and communicate with the instructor to form main course information. In addition, student learning outcomes can be reflected by online learning satisfaction, which is repeatedly proposed by the OCL, the learning satisfaction can motivate the learners to build a communication bridge with the instructors (Rahman et al., 2021; Isaac et al., 2019). It is important to note that, the learning value is parallel with the whole-person development of the student, so they can share knowledge and have better career planning (Ireland & Lent, 2018).

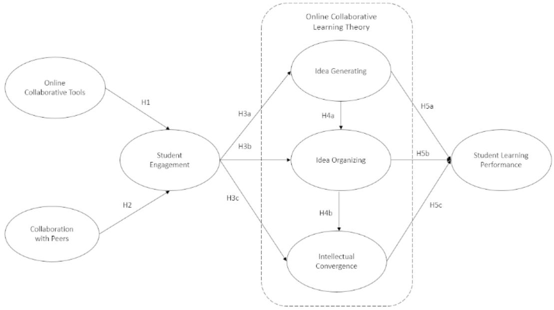

Fig. 1 Research model

H5a: Students' idea generation within the context of OCL positively influences student learning performance.

H5b: Students' ideas organization within the context of OCL positively influences student learning performance.

H5c: Students' ideas convergence ability within the context of OCL positively influences student learning performance.

Therefore, the current study tends to integrate OCL and related factors to strengthen student learning outcomes and achievements. Figure 1 depicts the proposed theoretical framework.

3 Method

3.1 Sample and data collection

Participants were recruited from Sojump (http://www.sojump.com), a popular online survey platform in China with more than two -week data collection process. Judgmental sampling method was used for the study to collect information from university students in China based on two inclusion criteria. First, participants were asked at the beginning of the survey whether or not they have used online collaborative learning tools (e.g. Zoom, Tencent Meeting, Teams Meeting, etc.) to have online lessons with their lecturers and classmates in the last 3 months. Second, participants were further asked if they used online collaborative learning tools (e.g. Zoom, Tencent Meeting, Teams Meeting, etc.) to conduct group discussion with their groupmates during the tutorial or lecturer class in the last 3 months. If participants fulfil both inclusion criteria, they were invited to complete an online survey. Therefore, participants who have not fulfilled the above two conditions had to withdraw from this study. At last, a total of 373 students (Female = 179, 48% Male = 194, 52%) were recruited with age ranged from 17 to 25. There are 335 (89.8%) undergraduate students, 36 (9.6%) master's degree students and 2 (0.6%) doctorate degree students. Among the participants, 144 (38.6%) students' monthly family income was ¥10,001 to ¥30,000, 77 (20.6%) students' family income was below ¥10,000.

3.2 Instruments and measures

The questionnaire was prepared based on previous studies (Hernández-Sellés et al., 2019; Qureshi et al., 2021; Isaac et al., 2019) and OCL Theory developed by Harasim (2012). The measures were adapted and modified from prior research to suit the context of online collaborative learning. The online survey instruments consisted of 33 items that examined the factors of online collaborative tools (5 items), collaborative with peers (4 items), emotional engagement (5 items), idea generating (4 items), idea organizing (4 items), intellectual convergence (5 items) and students learning outcome (6 items). The seven-point Likert scale ("1 = strongly disagree" to "7 = strongly agree") was used to measure all the items in this survey. Specifically, to operationalize online collaborative tools, we used measurement items adapted from Hernández-Sellés et al. (2019). For collaboration with peers as well as emotional engagement, we used measurement items adapted from Qureshi et al. (2021). Finally, for student learning performance, we used measurement items adapted from Isaac et al. (2019).

To operationalize OCL concept, recent research advances in knowledge management process are examined (Gold et al., 2001; Anwar & Ghafoor, 2017; McNichols, 2010; Yazdani et al., 2020) The research work of knowledge management process (i.e. knowledge acquisition, knowledge refinement and knowledge application) from Gold et al. (2001) provided a theoretical foundation for OCL. Therefore, the constructs of idea generating, idea organizing, and intellectual convergence are operationalized and adapted from previous studies in knowledge management, in particular from knowledge generation, refinement and application literature (Gold et al., 2010). To our knowledge, this is the first empirical study to operationalize and examine the 3 components of Harasim (2012) framework adapted from knowledge management perspectives.

3.3 Data analysis

Using the software application of SmartPLS 3.0, the Partial Least Square Structural Equation Modeling (PLS-SEM) was applied to analyze the proposed model (Ringle et al., 2015). The SEM approach has more advantages over other alternative technology such as regression analysis. All the model variables can be performed by SEM simultaneously rather than analysis separately, thus results in a more accurate assessment (Sarstedt et al., 2017). Additionally, covariance-based methods were adopted by PLS-SEM for the below reasons. First, it does not require normal distribution. Second, PLS-SEM can manage complex models with many indicators. Third, suggested by Hair et al. (2016), the minimum sample size should follow 10 times rule, which is 10 times the maximum number of inner or outer model links of all the latent variables of the research model. The model of the present study features ten main paths leading to student learning outcomes. Based on Hair et al. (2016)'s suggestion, the minimum sample size suggested for the study should be greater than 100; therefore, the sample size of 373 is adequate.

4 Results

Hair et al. (2017) recommended a two-step approach to assess the research model of the study. Reliability and validity and discriminate validity were evaluated with measurement model. Then, the research hypotheses were tested with the structural model.

4.1 Measurement model

According to Hair et al. (2016), measurement model is assessed through a three-step approach. First, we tested the composite reliability (i.e. internal consistency of our model). The acceptance level (i.e. threshold level) of the composite reliability should be higher than 0.7. As the results shown in Table 1, all the latent variables meet the acceptable range of 0.70 or higher. Second, we tested the convergent validity to determine the extent to which a question item relates to other question items of the same construct, which can be measure by the average variances extracted (AVE) value of the latent variable. Hair et al. (2016) suggested that the level of AVE of 0.5 or higher is acceptable and results of the present study shows that the AVE values of all the latent variables meet the acceptable range. Third, we tested the discriminant validity to make sure the measure of one construct is not related to other constructs using Heterotrait-monotrait (HTMT) ratio method (Henseler et al., 2015). The HTMT ratio suggested by Henseler et al. (2015) is less than 0.90. Accordingly, results of the present study shows that all the values of HTMT were less than 0.90, achieving the acceptance level (see Table 2).

4.2 Structural model

The structural model was tested after assessing the reliability and validity by the measurement model. Using the bootstrap method of the PLS, the path coefficients and t-values were calculated. The results suggested that all ten proposed associations were significant with 5000 resampling iterations tested by the bootstrapping. The path coefficient, t-values and p-values (the results of the hypothesis testing) are shown in Table 3. The summary of PLS-SEM analysis suggested, online collaborative tools ($\beta=0.288$, $t=4.163$) and collaboration with peers ($\beta=0.522$, $t=8.025$) have a positive and statistically significant relationship with the emotional engagement of students, supporting hypothesis H1 and H2. Emotional engagement of students is also positively and significantly associated with OCL, idea generating ($\beta=0.639$, $t=12.037$), idea organizing ($\beta=0.237$, $t=3.060$), and intellectual convergence ($\beta=0.196$, $t=2.242$), supporting H3a, H3b and H3c. In between OCL, idea generating is positively and significantly related to idea organizing ($\beta=0.563$, $t=6.633$) while idea organizing is positively and significantly associated with intellectual convergence ($\beta=0.605$, $t=7.375$), supporting H4a and H4b. Finally, students learning outcome is positively and significantly predicted by OCL, idea generating ($\beta=0.182$, $t=2.647$), idea organizing ($\beta=0.271$, $t=3.101$) and intellectual convergence ($\beta=0.380$, $t=4.597$), supporting H5a, H5b and H5c.

5 Discussion

Previous studies provided inconsistent results about the learning effectiveness of OCL. Some found OCL leads to better learning performance (Qureshi et al., 2021), but others found that OCL is not always effective for learning (Thompson & Ku, 2006; Margaliot & Gorev, 2020). To address the inconsistent findings, this study empirically examines the effectiveness of OCL in higher education. Based on our findings, it is found that technology characteristics, peers' interactivity, student engagement are major exogenous factors affecting effectiveness of students' learning performance in the OCL process. By understanding these factors, the use of OCL for learning and students' development can be encouraged and promoted.

In particular, our results show a greater explanatory powers of the students' learning performance (R^2=56%), and other major dependent variables, such as student engagement (R^2 =55.1%), idea generating (R^2=40.8%), idea organizing (R^2=54.3%) and intellectual convergence (R^2=54.6%) (Fig. 2). Our research empirically found a strong association between online collaborative tools and student engagement, and peers' collaboration and student engagement. Overall, the results are consistent with the study of Molinillo et al. (2018) and Qureshi et al. (2021) and conclude that OCL allows peer interaction through generating and organizing ideas, and discussion among group members, leading to desired learning outcomes.

The positive impacts of student engagement on student learning outcomes through OCL process provide significant implications for higher education. This study found that students who interact more frequently with their peers tend to have higher level of engagement. The greater level of student engagement facilities idea generation, idea organization and intellectual convergence in the OCL process.

The findings in this study contribute to the literature of integrated models for OCL adoption. Prior research used and tested the integrated model of Technology Acceptance Model (TAM) (Yadegaridehkordi et al., 2019; Park et al., 2019) regarding OCL intention. In addition, our research empirically employed OCL theory developed by Harasim (2012)'s framework to examine students' learning performance through OCL process (i.e. idea generating, idea organizing and intellectual convergence). To our knowledge, this is the first study to operationalize and empirically examine the 3 components of Harasim (2012)'s framework adapted from knowledge management perspectives.

The study also examined the links between peers' collaboration and students' learning performance. The results showed the indirect impact of peers' collaboration on students' learning performance through various academic activities, such as student engagement and student-teacher interaction via OCL process. This finding provides an important implication for higher education institutions on encouraging student engagement as well as teacher involvement. Teachers can communicate with their students by email after the OCL activities to further understand students' needs and expectations, and such attentions enhance student engagement (Kim & Lundberg, 2016).

To accomplish students' intended learning outcomes, teachers should organize meaningful educational activities related to objective outcomes of that particular online lesson. In addition, making effective OCL requires scaffolding from teachers

Table 1 Reliability and Validity

Scale & items	Loadings	Composite reliability	AVE
Online collaborative tools		0.884	0.603
The virtual campus tools have helped the work team members to collaborate.	0.793		
The team's discussion forum allowed a fluid exchange of information.	0.752		
The team's discussion forum allowed establishing personal links.	0.825		
The chat has allowed me to establish personal connections with the members of my team.	0.778		
I consider that enough tools are provided in the virtual campus for collaborative learning to be carried out.	0.732		
Collaboration with peers		0.874	0.635
I actively exchange my ideas with group members regarding project.	0.804		
I am able to develop new skills and knowledge from other members in my group.	0.815		
I am able to develop problem solving skills through peer collaboration.	0.776		
I am able to develop more comprehensive understanding of the topics through group discussion.	0.792		
Student engagement		0.863	0.559
The collaborative work is fun.	0.780		
I enjoyed thinking about the collaborative work	0.744		
Learning is interesting to me.	0.712		
The project work has favored my personal relationships with my peers and teachers.	0.742		
I feel that my opinions have been taken into account in project work.	0.758		
Idea generating		0.862	0.610
My instructor uses feedback from my group's progress report to improve subsequent projects.	0.798		
I exchange ideas with my groupmates.	0.746		
My groupmates are devoted to generating new ideas.	0.791		
I acquire knowledge with my groupmates and the assistant of my instructor.	0.787		
Idea organizing		0.865	0.615
My groupmates and I absorb generated ideas from individuals into an organized manner.	0.762		
I integrate different sources and types of ideas with my groupmates.	0.797		
My instructor assists my group to replace outdated ideas.	0.772		
I organize knowledge with my groupmates.	0.805		
Intellectual convergence		0.873	0.579
My groupmates and I apply the organized ideas in learning.	0.710		
I use the ideas to solve new problems with my groupmates.	0.748		
My ideas adjust strategic direction of the collaborative projects with my groupmates.	0.811		
My instructor assists my group to make ideas accessible in learning.	0.768		
My groupmates and I use transfer ideas into knowledge to improve project efficiency.	0.764		
Student learning outcome		0.89	0.599
Online learning helps me to accomplish my tasks more quickly.	0.746		
Online learning improves my learning performance.	0.822		

Table 1 (continued)

Scale & items	Loadings	Composite reliability	AVE
Online learning enhances my academic effectiveness.	0.807		
Online learning helps reviews and eliminate errors in my work tasks.	0.761		
Online learning helps me to realize my future target.	0.794		
Online learning helps me acquire new knowledge.	0.707		

Table 2 Discriminant validity of measurement model – based on the HTMT ratio

Construct	Collaboration with peers	Idea generating	Online collaborative tools	Student learning outcome	Emotional engagement	Intellectual convergence	Idea organizing
Collaboration with peers							
Idea generating	0.670						
Online collaborative tools	0.810	0.771					
Student learning outcome	0.678	0.789	0.820				
Emotional engagement	0.894	0.801	0.753	0.613			
Intellectual convergence	0.764	0.811	0.877	0.866	0.648		
Idea organizing	0.772	0.863	0.849	0.825	0.759	0.899	

Table 3 Summary of PLS-SEM Path Analysis

Path	Hypothesis	path coefficients	t-statistics	p-values
Online collaborative tools ◊ emotional engagement	H1	0.288	4.163	0.000***
Collaboration with peers ◊ emotional engagement	H2	0.522	8.025	0.000***
Emotional engagement ◊ ideas generating	H3a	0.639	12.037	0.000***
Emotional engagement ◊ idea organizing	H3b	0.237	3.060	0.002**
Emotional engagement ◊ intellectual convergence	H3c	0.196	2.242	0.025*
Idea generating ◊ idea organizing	H4a	0.563	6.633	0.000***
Idea organizing ◊ intellectual convergence	H4b	0.605	7.375	0.000***
Ideas generating ◊ student learning performance	H5a	0.182	2.647	0.008**
Idea organizing ◊ student learning performance	H5b	0.271	3.101	0.002**
Intellectual convergence ◊ student learning performance	H5c	0.380	4.597	0.000***

*p < 0.05; **p < 0.01; ***p < 0.001

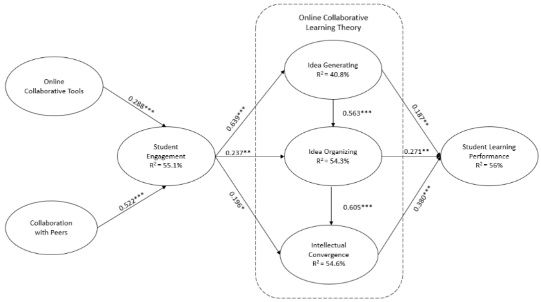

Fig. 2 PLS results of the structural model

that they support and interact effectively with their students in achieving the goal (i.e. student learning outcomes). Teachers should facilitate active participation, idea sharing and exchange among the groups. For example, during group discussion of OCL activities, the instructor would create different virtual breakout rooms using OCL tools. Then the instructor will join in different groups and listen to different groups' ideas sharing. The instructor would provide constructive feedback during the OCL discussion, and the group would present their findings at the end of the OCL activities. The student-instructor interaction via OCL activities would enhance students' cognitive skills, such as critical thinking skills, oral communication skills, and analytical skills, ultimately leading to students' learning performance. Teacher involvement increases student engagement that allows them to share, exchange ideas and in the OCL process (Hernández-Sellés et al., 2019).

Peers' collaboration has a direct impact on student engagement; thus, building teamwork is necessary to ensure the success of collaboration. The findings conclude that the more interaction among group members, the more the students tend to have a high engagement to their OCL activities, fostering cognitive skills and development. Students should interact with their team members frequently to develop the common goal of online collaborative learning, and they need to understand the intrinsic value of learning with others so that they are responsible for their own learning (Molinillo et al., 2018). Moreover, appropriate online collaboration tools have a direct impact on student engagement in this study, which is found to be the fundamental for facilitating student engagement, promoting efficient online environments for active collaborative learning. The communication tools enable students' interaction with their peers and teachers that students can communicate in work groups (e.g. online breakout rooms) to foster fruitful discussion via OCL process.

5.1 Managerial implications

The study provides managerial implications for higher education institutions. This study suggests institutions to motivate teachers to implement OCL in their teaching to increase students' learning performance. Teachers should design appropriate OCL activities and enhance student engagement in group discussions and projects. Due to the COVID pandemic, OCL begins to be very common and it's about the time to change traditional ways of teaching into online collaborative learning. OCL involves active participation among students and teachers should provide pedagogical guidance to students for learning collaboratively. In addition, Institutions play an important role in putting more resources to invest in technological infrastructure. With appropriate online collaborative technology, institutions can provide comfort and easiness online environments for students to communicate with their members for knowledge sharing and generation which ultimately strengthen student learning performance.

6 Conclusions

This study aimed to investigate the impact of online collaborative tools and collaboration with peers on student engagement via OCL process which eventually increase students' learning performance in Chinese context. All the hypotheses are supported in the model and the findings of this study provide a comprehensively understanding about students' learning performance in OCL process. This study is the first study to operationalize the constructs of idea generating, idea organizing and intellectual convergence of the OCL process developed by Harasim (2012)'s framework. The study illustrates that there is a significant relationship between student engagement and OCL activities. The study concludes that OCL promotes student engagement and teacher involvement to facilitate group discussion. In addition, this study contributes to the literature by proposing a model that incorporates OCL theory and concepts, as well as operationalizing the three components of the OCL process. The proposed model has a good fit to the data, and the model is validated. Providing necessary resources by higher education institutions increase the appropriateness of online technologies and facilities so as to increase the willingness of students to participate in OCL actively.

6.1 Limitations and future directions

There are some limitations in this study. First, our samples included participants from Chinese context. Future research can consider other countries, such as Japan, Singapore or Taiwan, etc. Second, this study was the first to operationalize the three constructs of OCL process developed by Harasim (2012). Future research would further validate the constructs using cross-sectional survey analysis.

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Conflict of interest

None.

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