Examining self-regulated learning as a significant mediator among social presence, cognitive presence, and learning satisfaction in an asynchronous online course: A partial least squares structural equation modeling approach

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Using a 33-item 5-point Likert scale and partial least squares structural equation modeling approach, this study examined the role of 347 Chinese college first-year students' self-regulated learning as a mediator among social and cognitive presences and their learning satisfaction in an asynchronous online course during the COVID-19 pandemic. Specifically, it examined the extent to which their self-regulated learning and cognitive presence mediated the influence of social presence on their learning satisfaction. The results indicated that participants' self-regulated learning had a significant positive effect on their learning satisfaction. It also had a significant mediation effect between social presence and their learning satisfaction, as well as between social and cognitive presences. Furthermore, social presence played a significant role in participants' self-regulated learning and their learning satisfaction through the mediation of their self-regulated learning and cognitive presence. Implications for designing asynchronous online courses are discussed.

Implications for practice or policy

- Course designers should consider how to leverage and increase students' social presence in the asynchronous online learning environment.
- Course designers should make it a priority to clarify learning goals, inform learning activity time, provide prompt feedback, design appropriate autonomous tasks, arrange appropriate social learning activities, and specify optional online learning paths.
- Course designers should foster learners' self-regulated learning, help them build online confidence, manage their time well, and overcome difficulty in completing the online learning tasks.

Keywords: self-regulated learning, community of inquiry, PLS-SEM, social presence, cognitive presence, learning satisfaction, mediation effects

Introduction

In the past 2 decades the educational system has moved towards online learning (Jeetendra & Mythili, 2021; Li et al., 2022; Lu et al., 2020). Related research has investigated various factors affecting students' online learning process and satisfaction (Akyol & Garrison, 2011; Garrison et al., 2010; Jeetendra & Mythili, 2021; Richardson et al., 2017). Garrison et al. (2000, 2001) proposed the community of inquiry framework for such investigations. They believed that real and meaningful learning occurs with the interaction of the three (i.e., teaching, social, and cognitive) presences perceived by students in the online learning community (Garrison et al., 2000, 2001). These presences have also been widely recognised by the researchers in the field (Castellanos-Reyes, 2020; Fiock, 2020; Garrison, 2009, 2011; Garrison et al., 2000,

2001; Patwardhan et al., 2020; Shea & Bidjerano, 2013; Stenbom, 2018). Based on the community of inquiry framework, Shea and Bidjerano (2010, 2012) posited that online learner self-regulation moderates the relationships among the cognitive, teaching, and social presences. Shea and Bidjerano (2012) further claimed that when an online learning experience lacks adequate teaching and social presences, the online learner self-regulation can make up for them. Some researchers further argued that students' self-regulated learning becomes an important factor for explaining their satisfactory online learning experiences (Broabent & Poon, 2015; Cho et al., 2017). Furthermore, research has indicated that students' self-regulated learning significantly influences their learning satisfaction and outcomes in online courses (Broabent & Poon, 2015; Kuo et al., 2013; Cho et al., 2017). More recent studies, during the global COVID-19 pandemic, students have shown decreased learning motivation, performance, and satisfaction (Chung et al., 2020; Tan, 2021). Helping students regulate their own learning was shown as an effective strategy to engage students in productive online learning by Wang et al. (2021). It has also been shown that students have to take more responsibility for their learning in an online environment than face-to-face settings (Barnard et al., 2008; Cho et al., 2010). Therefore, it is important to examine the extent to which students' self-regulated learning can impact their learning satisfaction in an asynchronous online course.

Literature review

Elements of the community of inquiry framework

The community of inquiry framework is a process model that describes the essential elements of a successful online learning experience in higher education (Garrison et al., 2000, 2001). Garrison (2017) asserted that the core function of this framework is to manage and monitor the dynamic process for thinking and learning collaboratively. There are three unique and interrelating elements such as the cognitive, teaching, and social presences within the community of inquiry framework. The process of learning is outlined by the cognitive presence. The guidance of the inquiry is described by the teaching presence. The human experience of learning is outlined by the social presence (Garrison et al., 2000, 2001). Since the inception of the framework, it has been substantially used, discussed, and examined by researchers in the field (Castellanos-Reyes, 2020; Fiock, 2020; Garrison & Arbaugh, 2007; Garrison, 2011, 2017, 2022).

The relationships among the community of inquiry elements and students' learning satisfaction

Arbaugh et al (2008) developed a 34-item Community of inquiry survey of the cognitive, teaching, and social presences. It was proved to be valid and reliable. In particular, the Kaiser-Meyer-Olkin measure of sampling adequacy was .96, showing that data were suitable for factor analysis. Further, the scree plot suggested a 3-factor model (teaching presence, social presence, cognitive presence), which explained 61.3% of the total variance. Cronbach's alpha values showed internal consistency coefficients of .94 for teaching presence, .91 for social presence, and .95 for cognitive presence, respectively. Previous literature also helped move the community of inquiry research forward through more substantial data analysis and large-scale research studies across multiple disciplines and institutions (Garrison, 2017). Using the community of inquiry survey, relationships among the elements of the community of inquiry framework and their relationships with other variables were examined by verifying causal relationships, exploring predictions, and building structural models. For example, Akyol and Garrison (2008) found positive correlations among the teaching, cognitive, and social presences, and students' perceived learning satisfaction in an online course. Similarly, Kozan and Richardson (2014) reported strong positive correlations among the three elements. Furthermore, other researchers reported causal relationships among the presences of the community of inquiry framework, that is, teaching and social presences have a significant perceived influence on the cognitive presence (Garrison et al., 2010; Gutiérrez-Santiuste et al., 2015; Lin et al., 2015; Shea & Bidjerano, 2009). Recently, Patwardhan et al. (2020) found that course design mediates the relationship between the community of inquiry elements and students' satisfaction. Lim and Richardson (2021) reported that differences exist across disciplines in terms of how each presence in the community of inquiry framework can predict students' learning achievement and satisfaction.

Students' learning satisfaction is an indicator of whether they are satisfied with their online learning experience (Li et al., 2016). Social presence has been found to have a significant effect on students' learning satisfaction and achievement (Richardson et al., 2017; Zhan & Hu, 2013). Moreover, Joo et al. (2011) found that learners' satisfaction, social presence, and cognitive presence are critical factors for successful online learning.

Self-regulated learning being an important factor for online learning

The concept of self-regulated learning is defined as learners' systematic effort to manage their learning process to attain personal goals (Zimmerman & Schunk, 2011). Self-regulated learners know how to set their goals, plan their tasks, monitor their progress, and evaluate their achievement in the learning process (Cho et al., 2017). The self-regulation learning process is underpinned by learners' motivation and use of cognitive strategies (Broadbent & Poon, 2015; Zimmerman, 2008). Self-regulated learning is viewed as especially important during personally directed forms of learning (Zimmerman, 2008).

Possessing self-regulated learning skills is essential to students' success in such self-directed learning environments as massive open online courses (Jansen et al., 2020; Li, 2019) and is important in social forms of learning (Cho et al., 2017; Zimmerman, 2008). Shea and Bidjerano (2012) reported that online learner self-regulation moderates the relationships among the other components within the community of inquiry framework. Specifically, the learners' online self-regulatory cognitions and behaviours a have significant influence on their cognitive presence, and strong self-regulation as a compensation effect is needed to attain cognitive presence in the absence of sufficient teaching and the social presence (Li, 2019; Shea & Bidjerano, 2012). Hence, learners' self-regulated learning becomes an important factor in contributing to their online learning success (Barnard et al., 2009).

Aspects of self-regulated learning such as environment structuring, goal setting, time management, help seeking, task strategy, and self-evaluation are important to online learners as well (Barnard et al., 2008; Broadbent et al., 2021; Li, 2019; Wang et al., 2013). If online learners are better able to manage their study time effectively, structure their learning environment, and seek assistance when faced with setbacks, they are more likely to be successful (Broadbent et al., 2021; Hsu et al., 2009). Furthermore, learners' perceptions of course communication and collaboration partly influence their outcomes in online courses due to the affordances for self-regulatory learning behaviours such as asking each other for help, structuring the learning environment, and using learning strategies (Barnard et al., 2008). Moreover, Broadbent et al. (2021) posited that self-regulated learning characteristics could impact successful engagement with formative assessment, and subsequent summative performance in both online and blended learning formats. Li (2019) and Wang et al. (2013) found that students who used more self-regulated learning strategies such as rehearsal and elaboration tended to be more satisfied with the online course. Lai and Hwang (2016) found the flipped classroom model satisfying for students because it encourages self-regulated learning. Strelan et al. (2020) further explained that when a pre-recorded micro-class was provided to students before the class, they were more likely to develop good time management and organisational skills to keep pace with the new material. The student-centered in-class activities helped students develop a sense of self-efficacy.

Nowadays, most online courses are asynchronous, which can lead to complaints from students regarding lack of supervision and interaction. Research has indicated that more advanced cognitive levels cannot be naturally reached in an online inquiry community (Galikyan & Admiraal, 2019; Garrison & Arbaugh, 2007; Guo et al., 2021; Oh et al., 2018). Thus, it is important to explore alternative online course designs that may facilitate the attainment of higher levels of cognition, such as integration and resolution, through communication, interaction, and self-regulation. Intricate and integrated design is necessary for the best online course (Li et al., 2022), and strategies of self-regulated learning should be integrated into the online course to support students' learning. Research on self-regulated learning included in massive open online courses showed that the inclusion of short videos about self-regulated learning instructions and suggestions, positively affected learners' course completion, and improved self-regulated learning activities (e.g., Jansen et al., 2020).

Significance of the study

The literature review suggested that further examination of the causal relationships among self-regulated learning and other elements within the community of inquiry framework would be necessary. It would advance the research on online learning by providing helpful suggestions for the improvement of online course designs. In addition, the investigation of self-regulation learning and elements of the community of inquiry framework on students' learning satisfaction in the online learning environment may have important implications for online learners. For example, they may consider, improving their learning efficiency and increasing their learning motivation and satisfaction, especially in asynchronous online courses. The purpose of this study was to examine Chinese college first-year students' self-regulated learning and learning satisfaction in an asynchronous online course. Partial least squarew structural equation modeling approach was used in this study. The extent to which participants' self-regulated learning and cognitive presence mediated the influence of social presence on their learning satisfaction in this asynchronous online course was examined.

Hypotheses

Based on the literature, the following direct hypotheses were developed (see Figure 1):

H1: Self-regulated learning has a positive causal relationship with learning satisfaction.
H2: Social presence has a positive causal relationship with self-regulated learning.
H3: Self-regulated learning has a positive causal relationship with cognitive presence
H4: Social presence has a positive causal relationship with cognitive presence.
H5: Cognitive presence has a positive causal relationship with learning satisfaction.
H6: Social presence has a positive causal relationship with learning satisfaction.

Further, the following mediation hypotheses were formulated:

H7: Self-regulated learning mediates the relationship between social presence and learning satisfaction.
H8: Self-regulated learning mediates the relationship between social presence and cognitive presence
H9: Cognitive presence mediates the relationship between social presence and learning satisfaction.
H10: Self-regulated learning and cognitive presence mediate the relationship between social presence and learning satisfaction.

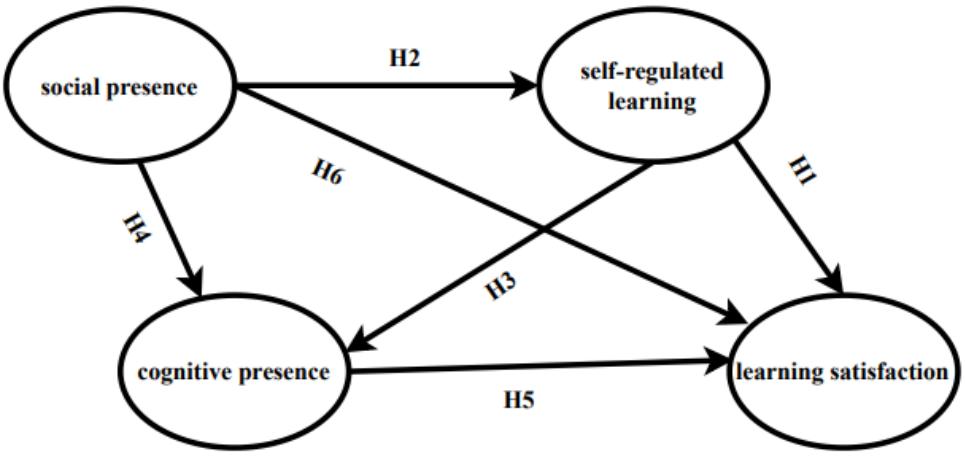

Figure 1. The hypothesised model

Research methods

Participants and context

All 374 first-year students from a university in central China who took the class "An overview of Chinese modern history" in Semester 1 of 2020, were invited to participate in this study. Due to the COVID-19 pandemic and unstable Internet connection, this online course was asynchronously delivered on the Chaoxing learning platform, where the course instructor communicated important class topics and goals, and provided the task list before each class. The course instructor also assigned homework for students to complete after class. Students were able to discuss problems with each other in a shared learning space supported by WeChat APP.

The returned questionnaires with the response time of less than 50 seconds were all removed. A total of 347 valid questionnaires were obtained. These participants' mean age was 19, with a standard deviation of .29. They came from 16 different majors. Among the 347 participants, 74 (21%) were male and 273 (79%) were female.

Data collection was conducted online with the assistance of the course instructor. The treatment of human subjects was in accord with the ethical standards and other requirements in China. The researchers provided all the participants with information of the study and consent forms; they all understood that their participation was totally voluntary, their responses were strictly confidential, and their non-participation did not influence course passing. This study involving human participants was reviewed and approved by the Evidence-based Research Center for Educational Assessment Research Ethical Review Board at Jiangsu University (Protocol #: ERCEA 2016).

Instrument

The instrument for data collection was a 33 item 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). It (Table 1) was constructed based on the previous literature (Arbaugh, 2001; Arbaugh et al., 2008; Barnard et al., 2008, 2009; Kuo et al., 2013; Lan et al., 2004; Shea & Bidjerano, 2008; Swan et al., 2008) to measure participants' social and cognitive presences, self-regulated learning, and learning satisfaction in this asynchronous online course. It is important to emphasise that this was an asynchronous online course where teaching presence including the instructional design and organisation, the facilitated discourse, and the instruction (Garrison & Arbaugh, 2007), was prerecorded and integrated into the course. Further, during the global COVID-19 pandemic many students complained that teaching in the asynchronous online classes was limited and their learning motivation decreased (Chung et al., 2020; Tan, 2021). Self-regulated learning naturally became a decisive factor for successful asynchronous online learning. Therefore this study focused on the relations among self-regulated learning, social presence, cognitive presence, and learning satisfaction. The instrument was first created in English with support from literature, and then translated into Chinese. The forward and backward translation procedures were used to guarantee the accuracy of the translation of all contructs (Sperber et al., 1994).

Table 1
Survey items and factor loadings

Item	Description	Factor loadings*
SRL1	I allocated extra studying time for this online course because I know it is time demanding.	.80
SRL2	I read aloud instructional materials posted online to fight against distractions.	.84
SRL3	I asked myself many questions about the course materials when studying for this online course.	.78
SRL4	I kept a high standard for my learning in this online course.	.78
SRL5	I prepared my questions before joining in online discussions.	.83
SRL6	I tried to schedule time daily or weekly and follow my schedule to study for this online course.	.78
SRL7	I reflected on my learning in this online course to examine my understanding of what I have learned.	.75
SRL8	I took thorough notes for this online course.	.70
SRL9	I interacted with my classmates to help me understand how I was doing in this online class.	.81
SRL10	I found someone knowledgeable in the course content so that I could ask him/her for help if I need it.	.83
SRL11	I set short-term (daily or weekly) goals as well as long-term goals (monthly or for the semester).	.80
SRL12	I was persistent in getting help from my online instructor when I need it.	.84
CP1	Combining new information helped me answer questions raised in course activities.	.84
CP2	Reflection on course content and discussions helped me understand fundamental concepts in this class.	.83
CP3	Problems posed increased my interest in the course issues.	.86
CP4	Brainstorming and finding relevant information helped me resolve content related questions.	.82
CP5	I can apply the knowledge created in this course to my work or other non-class related activities.	.84
CP6	I felt motivated to explore content related questions in this online class.	.85
CP7	I utilized a variety of information sources to explore problems posed in this online course.	.84
CP8	Online discussions helped students appreciate different perspectives.	.83
CP9	Learning activities helped students create solutions.	.80
SP1	I felt the teacher was by my side.	.73
SP2	Getting to know others gave me a sense of belonging in the course.	.77
SP3	I found online or web-based communication an excellent medium for social interactions.	.73
SP4	I felt that the class is a group that can communicate freely.	.84
SP5	I felt comfortable conversing through the online medium.	.83
SP6	I was able to form distinct impressions of course participants.	.83
LS1	I felt satisfied with the interaction with my peers in this online course.	.78
LS2	I felt satisfied with the learning environment of this online course.	.85
LS3	I felt satisfied with the discussion with my peers in this online course.	.87
LS4	I felt satisfied with the relationships with my peers in this online course.	.87
LS5	I felt satisfied with the collaboration with my peers in this online course.	.81
LS6	I felt satisfied with the overall delivery of this online course.	.76

Note. SRL = self-regulated learning, items were adapted from Barnard et al. (2008, 2009) and Lan et al. (2004); CP = cognitive presence, items were adapted from Arbaugh et al. (2008), Shea and Bidjerano (2008), and Swan et al. (2008); SP = social presence, items were adapted from Arbaugh et al. (2008), Shea and Bidjerano (2008), and Swan et al. (2008); LS = learning satisfaction, items were adapted from Arbaugh (2001) and Kuo et al. (2013). *Factor loadings were obtained from the PLS-SEM analysis.

Data analysis methods

Smart PLS 3.0 was used to perform the following data analyses: (a) measurement model analysis, (b) structural model analysis, and (c) mediation analysis. Measurement model analysis was used to check the reliability and validity of the measuring instrument. The data was tested for reliability, average variance extracted, and discriminant and convergent validity. The reliability of the constructs was initially examined. It should be the same or higher than the recommended criterion of .70 (Hair et al., 2017). The composite reliability of each construct was investigated. The cut-off level suggested in the literature was .70 (Hair et al., 2017). average variance extracted was also used to examine the convergent and divergent validity. The value of each construct's AVE's was higher than the recommended .50 (Fornell & Larcker, 1981).

The discriminant validity of the instrument was tested and verified so that all constructs in the instrument should not be substantially correlated (Hubley, 2014). To meet the heterotrait-monotrait ratio requirement, all values must be less than .90. (Henseler et al., 2016; Sarstedt et al., 2011). The variance inflation factor was also determined for each variable. Smart PLS 3.0 has various useful features for measuring the variance inflation factor, which assesses the degree of multicollinearity. The VIF values should be less than 3.3 (Petter et al., 2007). This study considered the impact of first to second-order factors on the constructs. The importance of the social and cognitive presence, self-regulated learning, and learning satisfaction indicators were first investigated in this study. After the measurement model had been verified as valid and reliable, the structural model was inspected. Finally, using the bootstrapping technique to evaluate the model fitness, the standardised root mean square of .051 was calculated. This was within the acceptable range (Hooper et al., 2008).

Results

Measurement model

This study assessed the measurement model's reliability, average variance extracted, discriminant, and convergent validity. Table 2 shows that the reliability for each construct ranged from .88 to .95, which is higher than the recommended limit of .70 (Hair Jr et al., 2017). The rho_A statistics show the composite reliability indicator computed on unstandarised factor loadings for each construct. A reflective model's convergent validity is also tested using composite reliability, because Cronbach's alpha may over or under estimate scale reliability, the composite reliability is regarded as a reliable measurement method (Garson, 2016). As can be shown in Table 2, the composite reliability for all constructs ranged from .91 to .96. This was greater than the cut-off level of .70 and supported the model's convergent validity (Hair Jr et al., 2016). Additionally, convergent and divergent validity were tested using average variance extracted (Shahbaz et al., 2020). The average variance extracted reveals the average communality for each latent factor in a reflective model (Höck et al., 2010). For all constructs, the average variance extracted ranged from .62 to .70, which was higher than the recommended threshold of .50 (Fornell & Larcker, 1981).

Table 2
Reliability and average variance extracted

Construct	Cronbach's alpha	rho_A*	Composite reliability	Average variance extracted
Cognitive presence	.95	.95	.95	.70
Learning satisfaction	.89	.90	.92	.70
Social presence	.88	.89	.91	.62
Self-regulated learning	.95	.95	.96	.63

Discriminant validity is the requirement that none of the instrument's constructs are not strongly correlated with one another (Fornell & Larcker, 1981). The discriminating validity of the factors included in the measurement model was evaluated following Fornell and Larcker's criterion. The square root of the average variance extracted for each construct was higher than the square of the inter-construct correlations (Fornell & Larcker, 1981). Table 3 shows the discriminant validity of all the constructs.

Table 3
Discriminant validity

	Cognitive presence	Learning satisfaction	Social presence	Self-regulated learning
Cognitive presence	.83			
Learning satisfaction	.73	.84		
Social presence	.71	.72	.79	
Self-regulated learning	.74	.78	.77	.79

The heterotrait-monotrait ratio correlation ratio was determined, as suggested by literature (Henseler et al., 2015), to assess the legality of discrimination. The maximum permissible result for the heterotrait-monotrait ratio to validate discriminant validity is .85. A higher value denotes a validity problem (Henseler etal., 2015). Table 4 presents the complete results of the heterotrait-monotrait ratio evaluation.

Table 4
The heterotrait-monotrait ratio

	Cognitive presence	Learning satisfaction	Social presence	Self-regulated learning
Cognitive presence				
Learning satisfaction	.84			
Social presence	.82	.83		
Self-regulated learning	.82	.84	.83	

The variance inflation factors of all constructs were evaluated to estimate the collinearity and the severity of multicollinearity. The variance inflation factor value should be less than 3.3 (Petter et al., 2007), and all variables had values that were below the cut-off value of 3.3.

Structural model

The adjusted R^2 was 61.3% for learning satisfaction and 67.1% for self-regulated learning, suggesting that 61.3% explained the impact of social presence, cognitive presence, and self-regulated learning on learning satisfaction, whereas 67.1% change in self-regulated learning by social and cognitive presence. At a 99.9% confidence level, all primary paths from social and cognitive presence toward learning satisfaction through self-regulated learning were significant. To investigate the nominal effect of the model, effect size f^2 was also calculated (Cohen, 1988). The cut-off values for effect size (f^2) were 0.02 for small, 0.15 for medium, and 0.35 for substantial effect size, respectively (Henseler et al. 2009). Table 5 showed that H6 had a small effect size; H1, H3, and H5 had medium effect sizes, whereas H2 and H4 had significant effect sizes. The outcome of the structural equation modeling with partial least squares for the suggested model are shown in Table 5. H6 had a small effect size; H1, H3, and H5 had medium effect sizes, and H2 and H4 had significant effect sizes.

Table 5
Path coefficients of proposed hypotheses

Hypothesis	Original sample *SD*	*t*	*p* value	Effect size (f^2)	Hypothesis supported
H1:Self-regulated learning -> Learning satisfaction	.35 .06	6.33	< .01	.177	Yes
H2: Social presence -> Self-regulated learning	.76 .03	25.61	< .01	1.399	Yes
H3: Self-regulated learning -> Cognitive presence	.42 .07	6.05	< .01	.263	Yes
H4: Social presence -> Cognitive presence	.49 .07	7.34	< .01	.363	Yes
H5: Cognitive presence-> Learning satisfaction	.37 .07	5.58	< .01	.160	Yes
H6:Social presence-> Learning satisfaction	.23 .06	4.11	< .01	.069	Yes

Self-regulated learning and learning satisfaction were significantly and positively correlated (β = 0.35, t = 6.33, p < .01). H1 was therefore supported. The association between social presence and self-regulated learning was substantial (β = 0.76, t = 25.61, p < .01). H2 was therefore supported. The correlation between self-regulated learning and cognitive presence was significant and positive (β = 0.42, t = 6.05, p < .01), which further supported H3. Social presence had a positive impact on cognitive presence (β = 0.49, t = 7.34, p < .01). H4 was therefore supported. Cognitive presence and learning satisfaction were positively associated and substantial (β = 0.37, t = 5.58, p < .01), supporting H5. The association between social presence and learning satisfaction was substantial (β = 0.23, t = 4.11, p < .01). H6 was therefore supported. The outcomes mentioned above are depicted in Figure 2.

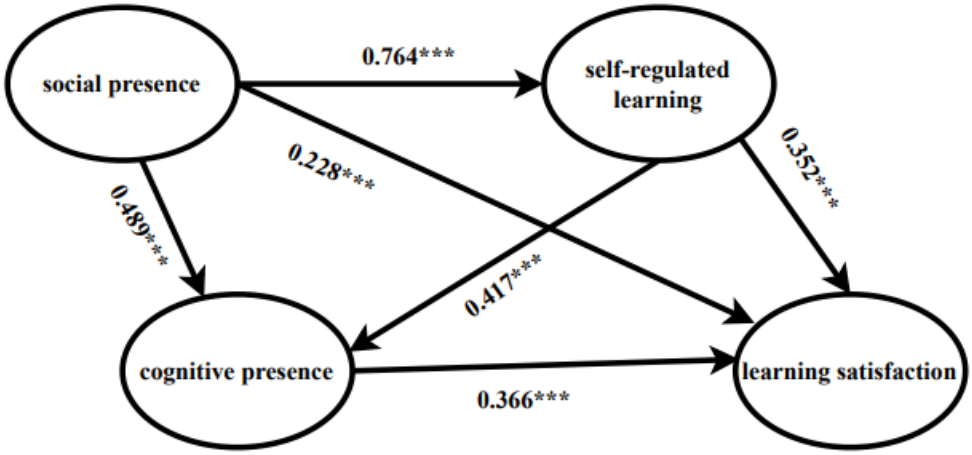

Figure 2. Path coefficient results of the proposed model

Mediation analysis

This study used the bootstrapping-focused protocols to test for mediation (Hayes, 2013; Hussain et al., 2021; MacKinnon et al., 2002). Using the Baron and Kenny approach, hypotheses H7, H8, H9, and H10 were evaluated to confirm the mediation role of self-regulated learning and social presence (Zhao, Lynch, & Chen 2010). In order to determine the mediating effect, the indirect effect must be significant (Gaskin et al., 2018; Sajid et al., 2022). After examining the model, social presence was found to have significantly influenced self-regulated learning, which in turn had a strong relationship with learning satisfaction. Social presence had both direct and indirect effects on learning satisfaction through self-regulated learning. Similarly, social presence had a direct and indirect relationship with cognitive presence through self-regulated learning. The findings of the four mediating hypotheses are shown in Table 6.

Table 6
Mediation analysis results

Hypothesis	Original sample	*M*	*SD*	*t*	*p* value	Supported
H7: Social presence -> Self-regulated learning -> Learning satisfaction	.269	.266	.048	5.591	< .01	Yes
H8: Social presence -> Self-regulated learning -> Cognitive presence	.318	.321	.052	6.078	< .01	Yes
H9: Social presence -> Cognitive presence -> Learning satisfaction	.179	.182	.038	4.739	< .01	Yes
H10: Social presence -> Self-regulated learning -> Cognitive presence -> Learning satisfaction	.117	.12	.029	4.023	< .01	Yes

Discussion

The mediating influence of cognitive presence on social presence and learning satisfaction

The results suggested that social and cognitive presences had positive effects on students' learning satisfaction. The direct hypotheses H4, H5, and H6 were supported. These results were consistent with the findings reported by Garrison et al. (2010) and Shea and Bidjerano (2009), that social presence has a significant perceived influence on cognitive presence. These results were also consistent with previous findings that the social and cognitive presences positively influence students' satisfaction (Akyol & Garrison, 2008; Guo et al., 2021; Lim & Richardson, 2021; Patwardhan et al., 2020; Richardson et al., 2017; Zhan & Hu, 2013).

Previous researchers have employed the meta-analysis to explore the relationship between social presence and students' satisfaction in online classes (Richardson et al., 2017; Shea et al., 2022). Their findings showed moderately large positive correlations between social presence and satisfaction, as well as large variations among the correlations due to course length, discipline area, and instrumentation. The results of this study also indicated that cognitive presence mediated the influence of social presence on participants' learning satisfaction, and the direct hypothesis H9 was supported. The results pointed to the possibility that interventions to the social presence may be particularly useful for students' learning satisfaction. Social presence was identified as an important factor that could motivate the learners and improve their learning. Further, social presence could enhance the atmosphere of active community learning by facilitating learner engagement and increasing learner interaction (Cohen & Holstein, 2018; Zhan & Hu, 2013).

The mediating influence of self-regulated learning, cognitive presence, and social presence on learning satisfaction

The results confirmed that self-regulated learning was important in the asynchronous online learning environment. The direct hypotheses, H1, H2, and H3 and the indirect hypotheses H7, H8, and H10 were supported. These findings were consistent with previous research findings suggesting that self-regulated learning has a positive effect on cognitive presence, and a significant mediation effect between social and cognitive presences (Shea & Bidjerano, 2010, 2012). Furthermore, this study found that self-regulated learning had a positive effect students' learning satisfaction and a significant mediation effect between

the social presence and students' learning satisfaction. Social presence played a significant role in students' self-regulated learning, and it also in students' learning satisfaction through the mediation of students' self-regulated learning and cognitive presence. These results were as expected because online learners, asynchronous online learners in particular, are generally better at managing their study time effectively, structuring the learning environment, and seeking assistance (Broadbent et al., 2021; Hsu et al., 2009). These findings were consistent with previous research findings that self-regulated learners tend to have more positive perceptions of online courses (Howland & Moore, 2002) and students who use more self-regulated learning strategies tend to be more satisfied with online courses (Li, 2019; Wang et al., 2013).

Previous research has indicated that the social presence is a very strong predictor of students' satisfaction with their courses (e.g., Richardson et al., 2017). Researchers posited that the social presence can overcome the potential negative reactions by intensifying stronger peer connections, decreasing feelings of isolation, and enhancing feelings of psychological connection and community. Further, students with high social presence tend to have high perceptions of learning and satisfaction with their course instructors (e.g., Arbaugh, 2001; Richardson et al., 2017; Zhan & Hu, 2013). These might be the reason why the social presence plays a significant role in learners' self-regulated learning, and in their learning satisfaction, through the mediation of students' self-regulated learning and cognitive presence. Therefore, the following two conclusions were made. First, students' self-regulated learning was substantially associated with their learning satisfaction in the asynchronous online learning environment. Second, students' self-regulated learning represents an important secondary distal among social and cognitive presences and their satisfaction in this asynchronous online learning environment.

Limitations

This study was limited in the following four ways. First, the participants were from a single university in China and took the same asynchronous online course. Even though the participants come from different majors, the generalisation of the results may be limited. Second, teaching presence was excluded in the design because: (a) the course was prerecorded broadcast and teaching was integrated and embedded in the course; and (b) the importance of students' self-regulated learning was highlighted in the study design. The exclusion of the teaching presence might limit the interpretation of the results. Third, self-regulation was treated as a central construct and specific types of self-regulation strategies were not differentiated in the study design. The explanation of the results may be limited. Finally, individual students may have had different online learning experiences, but to what extent their personal online learning experiences influenced their learning satisfaction with this asynchronous online course was not investigated. In particular, the COVID-19 pandemic and the requirement for emergency remote teaching could have influenced students' learning experience, learning satisfaction, self-regulated learning, and social and cognitive presences.

Implications and future research

The results of this study point to two implications for the asynchronous online course designers. First, it is important to consider how to leverage and increase students' social presence in the asynchronous online learning environment. Since most asynchronous online learning is video-centric, it may be useful to create a community and provide more social hints and scenarios for students. In addition, the inclusion of a shared online learning context with more student-student and instructor-student interactions to help them achieve higher social and cognitive presences, may assist. For example, setting up Wechat groups for learners to share information online, including instructor videos in the course design, and encouraging learner comments that appear along the timeline of an online learning video, could lead to higher social presence among learners.

Second, learners' self-efficacy, time management, and effort regulation are the strongest predictors of their online learning efficiency (Broadbent et al., 2021). Instructors must foster students' self-regulated learning, help them build online confidence, manage their time well, and overcome difficulty in completing the online learning tasks. We also suggested that asynchronous online course designers make

it a priority to: (a) clarify the learning goals, (b) inform learning activity time, (c) provide prompt feedback, (d) design appropriate autonomous tasks, (e) arrange appropriate social learning activities, and (f) specify optional online learning paths. The asynchronous courses in this study were pre-recorded. The course instructor provided students with learning tasks before the class and assigned homework after the class. In this task oriented teaching mode where the instructor's role was the designer and supervisor, learners' self-regulated learning became particularly important. The more instructor-student and student-student interactions occurred, the higher students' learning satisfaction would be.

Future researchers in this area could consider the above strategies as interventions to improve learners' online learning efficiency and academic performance. Further, more advanced and complex models could be hypothesised within the existing community of inquiry discourse to better understand the community of inquiry framework in practice and offer more practical implications. For example, specific types of self-regulation strategies could be considered in the design to examine both their direct and indirect effects on promoting students' learning satisfaction. In addition, more critical engagement with the understanding of learner contributions to online collaborative education including self, co, and shared regulation of learning could be considered. Finally, in addition to quantitative research methods, future researchers could consider using qualitative research methods in examining students' self-regulated learning and learning satisfaction in such asynchronous online classes.

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