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Teammate Familiarity in Distributed Computer-Supported Collaborative Learning: The Mediating Role of Social Presence

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Abstract

Owing to the limitations of computer-mediated communication (CMC), distributed CSCL (Computer-supported collaborative learning) has not always been as effective as desired. Despite recognizing the significance of group composition, the exploration of the function of teammate familiarity in distributed educational settings is restricted. This study explored the influence of teammate familiarity and social presence in a distributed CSCL setting by conducting an online survey of 288 Korean university students with experience in distributed CSCL. The results indicate that teammate familiarity increased the social presence experienced by students among their peers. Social presence subsequently enhanced teamwork satisfaction and, ultimately, increased self-assessed knowledge gain. More importantly, the relationship between teammate familiarity and teamwork satisfaction was mediated by social presence. Social media platforms and class webpages were the most widely used channels for students to get to know their teammates. Our study provided insights for improving the effectiveness of distributed CSCL and a framework for investigating social presence in satisfaction building in various contexts, including online education.

Keywords: distributed computer-supported collaborative learning, social presence, teamwork satisfaction, learning outcomes, teammate familiarity

Introduction

Computer-supported collaborative learning (CSCL) has emerged as a teaching and learning technique that uses different technological and pedagogical approaches to encourage the communal aspect of learning (Jeong et al., 2019). It has been widely applied in various learning environments, including classrooms, blended learning, and distance learning (Al-Samarraie & Saeed, 2018; Kreijns et al., 2003; Roberts, 2005; Suthers, 2006). The benefits of CSCL have been demonstrated from various angles (Dillenbourg et al., 2009; Gress et al., 2010; Kreijns et al., 2003). A meta-analysis has also revealed the positive effects of CSCL (Chen et al., 2018; Jeong et al., 2019). However, low engagement and poor satisfaction render CSCL a challenging process that may fail to produce desirable results (De Backer et al., 2022; Zhang et al., 2023).

The COVID-19 pandemic and the rapid growth of distance education have led to an increasing number of CSCL implementations in online and distributed formats. In this study, we use the term *distributed CSCL* to describe the CSCL in a distributed learning environment. Compared with offline CSCL, students engaged in distributed CSCL face added hurdles. Specifically, the modes of interaction and social distance limit social interaction in distributed CSCL (Surani & Hamidah, 2020; Zhang et al., 2023; Zheng et al., 2022). Additionally, establishing students' sense of community in online settings can be more difficult owing to the constraints of computer-mediated communication (CMC; Baturay & Toker, 2019; Kreijns et al., 2003). All these aspects place distributed CSCL at a disadvantage, making it crucial to enhance the efficiency and satisfaction of students in distributed CSCL.

As stated by Farland et al. (2019) and Post et al. (2020), group composition always plays an important role in designing collaborative learning. Allowing students to team up with individuals they are familiar with can lead to positive outcomes, including improved team building behaviors, greater satisfaction, and better group performance in traditional and blended learning settings (Adams et al., 2005; Castellá et al., 2000; Hinds et al., 2000; Janssen et al., 2009; Rockett & Okhuysen, 2002). However, existing studies have revealed several shortcomings. First, in the educational context, the impact of teammate familiarity has been explored in a very limited number of studies (Janssen et al., 2009). Additionally, many studies have incorporated teammate familiarity as a combined factor and overlooked its function as a distinct variable (Ku et al., 2013). Furthermore, the examination of the influence of teammate familiarity in a distributed educational context has been conducted in a restricted number of studies (Zhang et al., 2023).

To address the aforementioned research gaps and better understand the role of teammate familiarity in distributed CSCL, the following research objectives were set for this study. First, this research examined how the learning outcomes of distributed CSCL are influenced by the level of familiarity among group members. Second, in line with Janssen et al. (2009), teammate familiarity may not be directly related to behavioral learning outcomes, and the effects of mediating variables need to be considered. Therefore, this study investigated the mechanisms that underpin the correlation between teammate familiarity and learning achievements through social presence and teamwork satisfaction. Third, this study attempted to understand the process by which students become familiar with each other in a comprehensive online environment.

Literature Review

Collaborative Learning, Teammate Familiarity, and Satisfaction

Collaborative learning involves learners working together in groups to achieve shared learning objectives (Dillenbourg, 1999). Social construction theory (Caceffo et al., 2022) emphasizes that the acquisition of knowledge is based on a process of negotiation with others. Therefore, collaborative learning has been widely acknowledged as an effective instructional approach since the 1970s (Anderson et al., 2010). CSCL is also receiving increasing attention as a computer-mediated model of collaborative learning (Gress et al., 2010; Kreijns et al., 2002, 2003). The interest in distributed CSCL has increased with the popularity of distance education. CMC tools connect group members living in different geographical areas as well as facilitate synchronous and asynchronous communication and interaction during collaboration (Hernández-Sellés et al., 2019). In the current study, the term distributed CSCL is conceptualized as computer-supported collaborative learning in distance and distributed learning settings.

Teammate familiarity is commonly defined as the degree to which individuals are acquainted with other members of a group. In traditional face-to-face collaborative learning settings, teammate familiarity improves the affective learning outcomes of collaborative learning (Falcione et al., 2019; Ku et al., 2013). However, its impact on behavioral learning outcomes remains uncertain. Walther (1992) stated that as individuals become familiar with their learning partners, intimacy between them may increase. It has the dual benefit of not only decreasing the psychological distance created by physical separation but also aiding in surmounting the inherent constraints of the CMC medium, such as the absence of nonverbal cues. Therefore, we believe that teammate familiarity plays an important role in distributed CSCL.

Previous research has consistently reported that satisfaction is associated with positive learning outcomes (Goh et al., 2017; Van Alten et al., 2019; Zhonggen et al., 2019). In the current study, satisfaction is defined as student satisfaction with their distributed CSCL. Zhang et al. (2023) showed that teammate familiarity positively influenced student teamwork satisfaction with collaborative learning, both face-to-face and computer-supported. Drawing upon empirical findings, the present study puts forth the following hypothesis:

H1: Teammate familiarity increases students' teamwork satisfaction in distributed CSCL.

Social Presence

Social presence refers to the degree to which individuals perceive and experience a sense of connection, engagement, and presence in a social interaction or online environment (Short et al., 1976). The definition and evaluation of social presence in various empirical situations have garnered growing attention since its inception (Dahlstrom-Hakki et al., 2020; Kim & Song, 2016; Song et al., 2014). However, social presence is generally considered to be the psychological experience of engaging in interactions with others in a mediated environment while being unaware of the presence of technology (Biocca et al., 2003). Furthermore, Gunawardena and Zittle (1997) proposed that immediacy (the time lag between replies) and intimacy (the connection between interaction partners) during CMC are significant factors that affect social presence.

Social presence is regarded as one of the key elements in understanding CMC (Short et al., 1976). For example, social presence facilitates the psychological and physiological responses during CMC (Lombard & Ditton, 1997). According to the Community of Inquiry (CoI) framework (Garrison et al., 1999), the emphasis on social presence aligns with the idea of creating a supportive and interactive online learning environment. Therefore, social presence has been recognized as a vital component in fostering meaningful social interactions among educators and learners, as well as among students within an educational setting. Particularly, previous studies have documented that social presence is positively associated with students' learning experiences and outcomes (Hostetter & Busch, 2006; Swan & Shih, 2005).

In CSCL, strategies that promote a sense of connection and belonging among learners have been deemed critical (Harasim, 1993; So & Brush, 2008). Therefore, social presence has been identified as a predictor of decreased psychological distance in CSCL (Nam, 2017; So & Brush, 2008; Tseng et al., 2015). However, social presence may have a more complex role beyond being a predictive factor, as observed in various educational settings (Khan & Rafi, 2020; Kim et al., 2013; Lee et al., 2011). Furthermore, one of the most notable functions of social presence is that of a mediator, which explains the reason behind certain online behaviors resulting in particular experiences (Song et al., 2019). The present study predicted that social presence mediates distributed CSCL and proposed the following hypothesis:

H2: Social presence mediates the relationship between teammate familiarity and teamwork satisfaction in distributed CSCL.

Model Testing With Collaborative Learning Outcomes

Prior research has showcased the advantages associated with satisfaction derived from teamwork in the context of collaborative learning (He & Huang, 2017; Ku et al., 2013; Tseng et al., 2009). In particular, teamwork satisfaction was positively correlated with collaborative learning outcomes (He & Huang, 2017; Tseng & Ku, 2011).

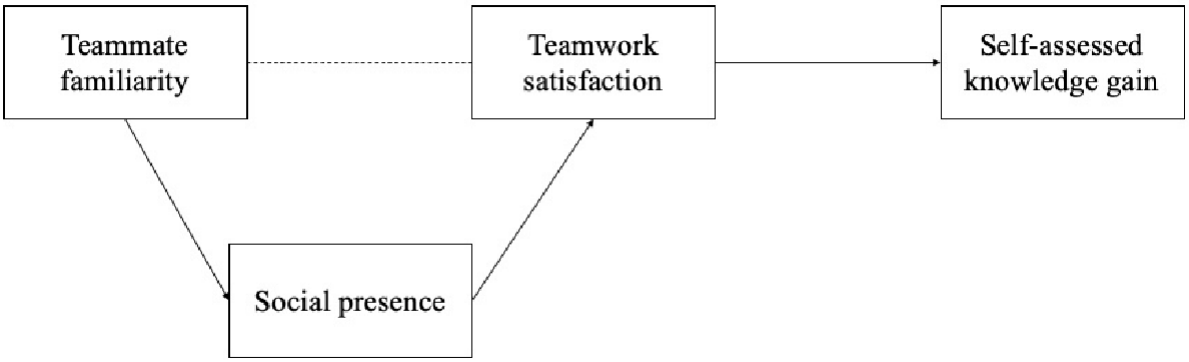
The objectives of higher education extend beyond mere academic knowledge acquisition; thus, comprehending the impact of the above-mentioned social factors on collaborative learning outcomes in educational environments is essential. Janssen et al. (2009) revealed that there is no significant association between familiarity and students' group performance. Conversely, Ku et al. (2013) suggested that team acquaintances and satisfaction are highly correlated. One reason for this inconsistency may be that teammate familiarity is an indirect rather than a direct factor that influences collaborative learning among students. More specifically, teammates may not automatically improve the collaborative learning outcomes of students. Instead, this may promote satisfaction, which may subsequently improve collaborative learning outcomes. Thus, student learning may result from the process that demonstrates the impact of teammate familiarity rather than being a direct outcome.

Drawing on the above information, this study has proposed a model that posits that teammate familiarity boosts teamwork satisfaction through social presence, as postulated in hypotheses H1 and H2. Thus, augmented satisfaction enhances the efficacy of collaborative learning. Figure 1 illustrates the proposed model.

H3: Self-assessed knowledge gain is positively affected by teamwork satisfaction, which is predicted by teammate familiarity and mediated by social presence.

Figure 1

Hypothesized Model Showing Proposed Relationship Between Social Presence and Measured Variables



To further understand practices that promote teammate familiarity in distributed CSCL, this study explored additional research questions. Specifically, given that CMC provides multiple channels of communication for students' learning processes, understanding students' use of communication channels to know and become familiar with their teammates provides meaningful insights. With this in mind, the following research question was pursued:

RQ: How do students get to know and become familiar with their peers in a distributed CSCL?

Method

Participants

Participants with experience in distributed CSCL were recruited from Korean universities. In total, 288 people returned completed questionnaires between August 3 and September 30, 2022. The participants' demographic characteristics are provided in Table 1.

Table 1

Sociodemographic Characteristics of Participants

Characteristic	*n*	%
Gender		
Male	121	42
Female	167	58
Educational level		
Undergraduate	224	78
Graduate	64	22
Discipline	121	42

Social science and humanities		
Natural science	167	58

Note. N = 288. Participants were on average 22.88 years old (SD = 2.74).

Procedure

An anonymous online questionnaire was administered. To eliminate any potential language comprehension difficulties for our subjects, we engaged the services of two proficient translators to render the questionnaire into Korean. This translated version was subsequently evaluated by two bilingual researchers. Furthermore, 15 Korean university students with experience in distributed CSCL participated in a pilot study to test and offer feedback and suggestions on the draft questionnaire. Finally, certain items were modified based on these suggestions. To recruit participants, we sent students a link to a Google form via social media platforms such as Kakao Talk.

Measures

In the first section, the students were provided with an explanation of the questionnaire's purpose and how the collected data would be used. After signing the consent form, students gave us demographic information, such as gender, age, nationality, educational level, and majors, and we then used the following screening question to select eligible participants: Have you ever participated in distributed collaborative learning?

The second section measured the level of teammate familiarity based on participants' recent experience of distributed CSCL using a 7-point Likert scale for those who had participated in distributed CSCL. To further clarify the meaning of teammate familiarity and rationally determine the rate of familiarity experienced by the participants, we composed three yes-or-no questions according to the study by Janssen et al. (2009). Examples of this type of question include: "Apart from online studies, my teammates and I have a connection in life," and "I have previously engaged in online collaboration with a few members of my group." Finally, the authenticity of the teammate familiarity measure was verified via three yes-or-no questions. The results revealed a significant correlation (r = 0.74, p < 0.02) between the three yes-or-no questions and teammate familiarity (M = 3.13, SD = 1.14).

The third section involved subscales related to social presence, teamwork satisfaction, and self-assessed knowledge gain, which were extracted and modified from existing online learning research. Social presence was measured by items cited from Song et al. (2019), such as "I feel like my teammates are learning with me in online collaborative learning," and "In my group, my teammates and I form an online community." Teamwork satisfaction was measured with items cited from Ku et al. (2013), such as "I enjoy working with my team on assignments or problem solving." Self-assessed knowledge gain was measured by items such as "I learn a lot from distributed computer-supported collaborative learning," and "I can interconnect the knowledge gained from distributed computer-supported collaborative learning" (Kim et al., 2016). On the 7-point Likert scale, all items were rated from *strongly disagree* to *strongly agree* or from *always* to *never*. The last section measured the ways for students to get to know and become familiar with their peers in a distributed CSCL.

Data Analysis

For data analysis, SPSS (Version 23) and Amos (Version 26) were employed in this study. First, we carried out descriptive and correlational analyses of the data with the help of SPSS. Subsequently, with the help of Amos, we completed model fitting analysis, parameter estimation, and path analysis.

Results

Reliability Examinations

The first step was to estimate the measurement model, e.g., the confirmatory factor analysis model, which described the extent to which the observed indicators measured the latent constructs. As shown in Table 2, the Cronbach's alpha values for all items exceeded the standard threshold of 0.70 (Tavakol & Dennick, 2011). All average variance extracted (AVE) values exceeded the recommended threshold of 0.5 (Fornell & Larcker, 1981). For composite reliability (CR), all values were greater than the recommended value of 0.7 (Bacon et al., 1995). Moreover, as shown in Table 3, we confirmed that each square root AVE value was greater than the inter-construct correlations in accordance with previous studies (Fornell & Larcker, 1981). We, therefore, confirmed that the questionnaire we developed passed reliability and validity tests.

Table 2

Assessing Questionnaire Quality: Reliability and Convergent Validity Analysis

Indicators	SP	TS	SKG
Cronbach's alpha	0.82	0.90	0.80
Convergence validity (AVE)	0.61	0.76	0.57
Composite reliability (CR)	0.82	0.90	0.80

Note. SP = social presence; TS = teamwork satisfaction; SKG = self-assessed knowledge gain.

Table 3

Discriminant Validity: Analysis of Inter-variable Variability

Constructs	TF	SP	TS	SKG
TF				
SP	0.557	0.780		
TS	0.535	0.805	0.870	
SKG	0.349	0.720	0.641	0.760

Note. TF = teammate familiarity; SP = social presence; TS = teamwork satisfaction; SKG = self-assessed knowledge gain.

Model Fit

Next, the structural model was executed to compute the fit indexes. As presented in Table 4, several important indexes, including the chi-square to the degree of freedom ratio (χ^2/df; Kock & Lynn, 2012), Tucker-Lewis index (TLI; Marsh et al., 1988), comparative fit index (CFI; Bentler, 1990), and Goodness-of-Fit index (GFI; Kline, 2005), as well as the root-mean-square error of approximation (RMSEA) (Steiger, 2007), were employed to evaluate the model fit. According to previous studies (Kline, 2015), we also list the criteria for each index in Table 4. Upon comparing these values with the standard benchmarks, it is evident that all our model indicators meet the acceptable criteria.

Table 4

Statistical Indicators to Assess Model Fit

Index	Criteria	Research model results
χ^2/df	$1 < \chi^2/df < 3$	2.993
GFI	> 0.9	0.940
CFI	> 0.9	0.960
TLI	> 0.9	0.943
RMSEA	< 0.08	0.080

Hypotheses Testing

To examine the aforementioned hypotheses, we conducted a path analysis. The results are presented in Table 5. The obtained path coefficients indicate that teammate familiarity is not significantly associated with teamwork satisfaction ($\beta = 0.12$, $p = 0.05$). Therefore, Hypothesis 1 is not valid. However, a positive association was found between teammate familiarity and social presence ($\beta = 0.53$, $p < 0.001$). Additionally, a strong and favorable correlation was present between social presence and teamwork satisfaction ($\beta = 0.89$, $p < 0.001$). More specifically, social presence mediated the relationship between teammate familiarity and teamwork satisfaction, which supports Hypothesis 2. Finally, the perceptions of knowledge gain and satisfaction were found to be significantly correlated ($\beta = 0.57$, $p < 0.001$), indicating that Hypothesis 3 is valid.

Table 5

Path Coefficients Between Teammate Familiarity and Measured Variables

Path	Estimate	*SE*	CR	*p*-value
TF→TS	0.12	0.06	1.99	0.05
TS→SKG	0.57	0.06	9.84	***
TF→SP	0.53	0.06	9.11	***
SP→TS	0.89	0.09	10.13	***

Note. CR = critical ratio; TF = teammate familiarity; TS = teamwork satisfaction; SKG = self-assessed knowledge gain; SP = social presence.

***$p < 0.001$.

Moderation Analysis

Finally, social presence was evaluated as a moderator. The outcomes presented in Table 5 reveal that the connection between teammate familiarity and satisfaction in distributed CSCL is significantly and positively influenced by social presence. Additionally, as the direct effect between teammate familiarity and teamwork satisfaction is not significant, social presence fully mediates the relationship.

Communication Channels for Getting Familiar

Further analysis was conducted to answer the main RQ concerning peer interaction in a distributed CSCL. The results are listed in Table 6.

Table 6

Communication Channels for Students in Distributed CSCL Settings

Channel	Students Who Accessed Channel	
	n	%
Social media	252	87.5
Class webpage	218	75.7
Email	62	21.5
Video conference	25	8.7

Note. $N = 288$.

Approximately 87.5% of participants ($n = 252$) reported that they get to know their teammates through social media platforms, followed by the class webpage (75.7%, $n = 218$), email (21.5%, $n = 62$), and video conferences (8.7%, $n = 25$).

Discussion

Learning is inherently social because students acquire knowledge through interactions with one another (Kalina & Powell, 2009). Effective communication and satisfaction building in CMC can be challenging owing to limited social cues and nonverbal information (Song et al., 2019). There is a wealth of literature that consistently underscores the pivotal importance of satisfaction in the efficacy of collaborative learning (Ku et al., 2013; So & Brush, 2008; Zhu, 2012); therefore, examining methods to foster satisfying teamwork in distributed CSCL is necessary. The present study investigated the influence of teammate familiarity and social presence on teamwork satisfaction and its contribution to collaborative learning outcomes.

The findings of this study suggest that familiarity among group members is not high in distributed CSCL environments ($M = 3.13$, $SD = 1.14$). We speculated that this result may be attributed to the following: first, the limitations of the online environment, such as limited nonverbal cues (Lo, 2008). Second, increasing familiarity through online communication is more difficult than in face-to-face settings (Pauwels et al., 2016). Third, the social distance limitations caused by COVID-19 resulted in a lack of opportunities for students to become familiar with each other (Vaterlaus et al., 2021). Knowing basic information about individuals is the first step toward building relationships (Song et al., 2019); therefore, the lack of knowledge regarding peers in distributed CSCL is likely to negatively impact teamwork satisfaction and potential learning outcomes. The results of the present study support this concern, suggesting that teammate familiarity affects the sense of social presence experienced in CMC, which subsequently affects satisfaction and ultimately self-assessed knowledge gain.

This study elucidates the potential mechanisms by which teammate familiarity affects teamwork satisfaction in a distributed CSCL environment. In particular, the findings of this study identify an important mediating role for social presence between teammate familiarity and teamwork satisfaction. This suggests that familiarity among group members can only contribute to the formation of effective relationships among students if it successfully enhances their sense of social presence. The present

study contributes to the theoretical understanding of the relationship between familiarity and relationship perceptions in distributed settings.

In this study, teammate familiarity is regarded as an independent variable within the context of distributed CSCL. Existing studies have examined teammate familiarity as a component of teammate relationships (Ku et al., 2013; Zhu, 2012). This trend appears to be compounded in the context of distributed CSCL, as familiarity with CMC has been confounded with the use of other relevant variables (Child & Petronio, 2011). In light of these observations, this study highlights inter-member familiarity as an important factor in enhancing social presence in distributed CSCL environments through independent measurement and exploration of teammate familiarity.

Existing literature explores the direct impact of social presence in online collaborative learning (So & Brush, 2008). However, the current study makes a significant contribution to advancing our understanding of social presence by emphasizing its mediating role in distributed CSCL. To our knowledge, this study is the first to explore the mediating role of social presence in distributed CSCL environments. In addition, this study demonstrates the importance of social presence on relational perceptions such as teamwork satisfaction in a collaborative learning context. With the increasing popularity of Internet-based applications in which individuals build relationships virtually (e.g., learning communities and learning groups), further research is required to understand the influence of social presence.

Our survey results show that in distributed CSCL, the familiarity of the team members reported by students is relatively low (M = 3.13, SD = 1.14). However, as the answer to our RQ indicates, social media platforms (n = 252 [87.5%]) and class webpages (n = 218 [75.7%]) are useful ways to help students get to know their teammates. Our findings further emphasize the complementary role of social media for online learning (Friedman & Friedman, 2013; Zhang et al., 2023), i.e., students' disclosure of personal information or active interaction with other students on social media provides an avenue for students to get to know each other. Furthermore, participants' profiles on the course homepage are also suggested as an aspect that cannot be ignored. Mutual understanding between students in a distance learning environment is also facilitated by encouraging them to provide relevant personal information on these homepages.

CSCL does not simply involve technology-assisted knowledge transfer or transmission but also involves student-to-student communication and connection (Hernández-Sellés et al., 2019). Therefore, the findings of this study have important practical implications. In distributed CSCL, teamwork satisfaction and, ultimately, self-assessed knowledge gain begin with familiarity with the group members. Our result is in line with previous studies (Hinds et al., 2000; Janssen et al., 2009; Rockett & Okhuysen, 2002), indicating that familiarity among teammates is the first step toward fulfilling the objectives of collaborative learning. Owing to the importance of distributed CSCL, we encourage active interaction between group members to increase familiarity with each other prior to engaging in collaborative learning. Furthermore, social media platforms and class webpages should also be actively used to help students get to know their teammates in distributed CSCL.

Limitations and Future Studies

Although this study contributes toward improving the efficiency of collaborative learning, some limitations exist. First, the current study has framed and scoped the research from an educational psychology perspective but has neglected the pedagogical and technical aspects of distributed CSCL. There is a great deal of diversity in the design and strategy of distributed CSCL activities, such as synchronous, asynchronous, or mixed synchronous and asynchronous activity designs. Future research could therefore explore how teammate familiarity contributes to distributed CSCL at diverse levels.

Another limitation of this paper pertains to the methodology employed. The data collection method relies on self-reported surveys; therefore, the measurement of student learning outcomes is based on students' subjective perceptions rather than objective assessments. Although, as mentioned in Song et al. (2016), university students are already considered capable of conducting valid self-assessments, it is important to acknowledge that self-reported results can still introduce a degree of inconsistency with the truth to some extent. Future research should therefore draw on experiments to analyze the role of teammate familiarity more scientifically and objectively in distributed CSCL.

Conclusion

The role of teammates' familiarity in the context of distributed CSCL is a controversial topic. Our study explains the controversial nature of research related to teammates familiarity by setting social presence as a mediating variable. Our findings suggest that there is no significant association between teammate familiarity and teamwork satisfaction. Instead, social presence plays a mediating role in the relationship between teammate familiarity and teamwork satisfaction. Additionally, there is a significant relationship between perceived knowledge acquisition and teamwork satisfaction. Finally, although the familiarity of teammates in distributed CSCL is relatively low, social media and the homepage of learning websites provide important channels for students to acquaint themselves with their teammates in a distributed learning environment.

With the popularity of distributed CSCL and online learning, the results of this study provide insights and strategies for practitioners to improve CSCL in distributed learning environments. Specifically, assigning students who are familiar with each other to a group may be an effective way of grouping students. Moreover, encouraging students to self-disclose and actively interact with other students through social media and the homepage of the learning website may help students get to know each other, thus improving the efficiency of distributed CSCL.

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Declarations

The authors declare that they have no competing interests.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Informed Consent

All participants were informed about the aim and scope of the study as well as the ways the data would be used. The respondents' participation was completely consensual, anonymous, and voluntary. Informed consent was obtained from all individual participants included in the study before they participated in the survey. The rights of respondents are safeguarded in this study, in line with the Declaration of Helsinki.

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