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Which Type of Interpersonal Interaction Better Facilitates College Student Learning and Development in China: Face-to-Face or Online?

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Abstract

Purpose: This study attempts to explore how Chinese college students engage in face-to-face synchronous and online asynchronous interactions and examine how the two different interaction types are associated with their academic learning (learning achievement and the development of research skills), satisfaction, and their perceptions of learning environments.

Design/Approach/Methods: A sample of 3,999 undergraduate students from a research university in Northern China participated in the survey. A series of cluster analysis, one-way analysis of variance, and hierarchical multiple regression were conducted.

Findings: The cluster analysis results revealed that there were four types of learners among these students and that a large percentage of Chinese undergraduates were classified into either digital communicators (36.16%) or passive interactors (32.71%). In general, the face-to-face synchronous interaction generated more desirable academic learning, perceptions of the learning environment, and higher satisfaction than the online asynchronous interaction in most aspects. However, the asynchronous online interaction fostered student autonomy and contributed to students' completion of an in-depth thesis.

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Originality/Value: By distinguishing face-to-face synchronous versus online asynchronous interactions, this study led to an enhanced knowledge of the interactive patterns of Chinese college students and uncovered the specific effects of the two types of interpersonal interactions in Chinese research universities.

Keywords

Face-to-face synchronous interaction, higher education, interpersonal interaction, online asynchronous interaction, student learning and development

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Struck by the coronavirus (COVID-19) pandemic, it is more urgent than ever for us to enrich our understanding of the online learning provided by higher education institutions (HEIs). In the past decades, digital technologies have facilitated distance communication and education, which are particularly supportive for informal and lifelong learning, with little cost but high flexibility (De Freitas et al., 2015). Ever since the outbreak of COVID-19 at the beginning of 2020, the ecology of global HEIs has been tremendously transformed by the Internet. In a review of the strategies adopted by a number of HEIs from 20 countries, universities and colleges across 19 countries, including China, rapidly closed their face-to-face operations and transferred to online education in diverse ways (Crawford et al., 2020).

Notably, amid the challenge of COVID-19, Chinese universities and colleges were the first among global HEIs to fully convert to online pedagogy (Crawford et al., 2020). Since the beginning of the 21st century, Internet-based environments and e-learning were first developed as a prototype in Chinese HEIs, thereafter undergoing many transitions and remarkable progress (Li et al., 2014; Lu et al., 2018; Zhao & Jiang, 2010). Nevertheless, the quality of Chinese distance education and communication at the tertiary level is still considered problematic and predictably unsatisfactory for coping with the pandemic situation when all the courses are compulsorily provided online. A major issue is that the e-learning platforms, such as Massive Open Online Courses (MOOCs) with its limited practices in some research universities in China, are now open to students of diversity, but the course completion rate could be lower than 3% (Lu et al., 2018; Shi & Yu, 2016). Therefore, it is the right time for the Chinese government and HEIs to reconsider how to assure the quality of undergraduate education in the digital era and to launch relevant actions as soon as possible.

Evidence-based approaches to the assessment of higher education quality are prevalent throughout the world (Astin, 1993, 2012; Kuh, 2009; Pascarella et al., 2010; Trowler, 2010). The quantity and quality of interpersonal interaction have been widely regarded as significant factors

influencing college student academic and social experiences (Astin, 1993, 2012; Pascarella et al., 2010; Stebleton et al., 2012). Student interaction with peers and faculty is included as significant indicators to depict the profiles of students and institutions (Coates, 2007; Trowler, 2010). More importantly, the social experiences of college students have been verified as having a number of educational benefits (Kim & Lundberg, 2016; Komarraju et al., 2010; Stebleton et al., 2012). However, although ample discussions have been formed on the social interactions of college students, they highlight the interactions in regular on-campus settings, rather than in virtual environments (Lundberg & Sheridan, 2015; Paulsen & McCormick, 2020; Redmond et al., 2018; Trowler, 2010). Previous studies, albeit more frequently carried out in the West, have drawn somewhat mixed conclusions when comparing face-to-face versus online communications. Some have argued that online communication embraces the tenet of constructivism and fosters the students' higher order cognitive processing (Cavana, 2009; Hrastinski, 2008), while others considered that it is difficult to create an inter-connected online learning community and is unlikely to lead to meaningful learning (Watts, 2016). It thus deserves a more context-specific and thorough investigation to provide nuanced answers. Especially, in the context of China, the students tend to be viewed as passive learners in traditional classroom settings (Sit, 2013). Chinese students were found to be more comfortable with delayed interactions on the Internet rather than with answering questions promptly (Tu, 2001), whereas the learning of Chinese students was also reported to be highly community driven (e.g., by teacher authority and peer collaboration), which would possibly be impeded by the fragmented nature of online communication (Wang & Woo, 2007; Zhu & Leung, 2011).

Particularly, research into Chinese research universities is rather meaningful, as these universities take leading positions in China in building e-learning platforms before and after the outbreak of COVID-19 (Crawford et al., 2020; Lu et al., 2018; Shi & Yu, 2016). It allows us to detect students' learning experiences comprehensively not only in their cognitive and affective development but also research-related ability and experiences. The latter has not been sufficiently covered in past inquiries (Astin, 1993, 2012; Kim & Lundberg, 2016; Komarraju et al., 2010; Stebleton et al., 2012; Trowler, 2010).

To sum up, this study attempts to take a step forward by exploring how students in Chinese research universities engage in face-to-face synchronous and online asynchronous interactions and by examining how the two different interaction types are associated with their academic learning (learning achievement and the development of research skills), satisfaction, and their perceptions of college environments. With a particular interest, this study intends to uncover students' preferences for interpersonal interaction and which interpersonal type is more beneficial for student learning and development in Chinese HEIs.

Theoretical framework

Students' college and social experiences in HEIs

For decades, the question of how the educational quality and standards in HEIs can be assessed and improved has confronted various higher education stakeholders including educators, administrators, and policymakers (Brint et al., 2008; Hu & McCormick, 2012). To answer the question, researchers have turned to students' college experiences that are believed to be able to boost their learning activities to meaningful outcomes and help students succeed in future professional and social environments (Astin, 1993, 2012; Coates, 2010; Kuh, 2009; Pascarella et al., 2010; Trowler, 2010). In the endeavors conceptualizing and measuring students' college experiences, how students engage in and devote themselves to academic and social activities and how they perceive the college environment have become the core constructs (Astin, 1984, 1993, 2012; Coates, 2010; Kahu, 2013; Trowler, 2010).

Astin (1993, 2012) has conducted systematic studies on student college experiences. In his Inputs–Environments–Outcomes (I-E-O) model, Astin lays out a longitudinal analytic framework incorporating student personal characteristics and pre-college levels (inputs), student college experiences (environments), and a number of intellectual and affective outcome variables (outcomes). The I-E-O model suggests that the improvement of student achievement and talent development are the results of both the inputs and environments. For instance, the high school performance of a student (an input construct) and how they engage in academic activities in the college (an environmental variable) may together determine their cumulative Grade Point Average (GPA) (an outcome variable). Moreover, Astin (2012) asserted that the inputs may interact with the environments. For example, given that students have divergent learning styles (an input construct), those attending the same class may have different learning experiences and thus may perceive their college environments differently. Therefore, on the one hand, the environment could be described by "the quantity and quality of physical and psychological energy that students invest in the college experience" (Astin, 1984, p. 518); on the other hand, learning environments are suggested to be produced by the students themselves and are recommended to be assessed from the standpoint of the individual (Astin, 2012).

The significance of students' social experiences together with the overall experiences in college has been iterated. Astin (1993, p. 398) illustrated that "the student's peer group is the single most potent source of influence on growth and development during the undergraduate years." Chickering and Gamson (1987) proposed *Seven Principles for Good Practice in Undergraduate Education*, two of which represent student–faculty contact and cooperation among students. Similarly, Coates (2007, p. 122) identified three social aspects out of six elements in the scope of student experiences, namely "collaborative learning," "formative communication with academic staff," and "feeling legitimated and supported by university learning communities."

In empirical studies, numerous large-scale surveys targeting college students have frequently encompassed their perceptions of learning environments and engagement in social activities. For example, the National Survey of Student Engagement, a national survey originating in North American HEIs and spreading to many other countries, collected information about students' interactions with faculty and peers, whether they took advantage of being a part of a learning community, and how supportive students perceived the college environment to be, among others (Coates & McCormick, 2014; Kuh, 2009). Similarly but specifically designed for research universities, another international survey, the Student Experience in the Research University (SERU), which originated in the University of California (Chatman, 2011; Klemenčič & Chirikov, 2015), included factors such as the frequency of interpersonal contacts and the degree of familiarity between faculty and students in the classroom and off-class campus environments. Researchers have also developed some other instruments, such as an internationally applied questionnaire, the Course Experience Questionnaire (Ramsden, 1991), and some instruments measuring learning environments, one of which has been validated with the sample of undergraduates in Chinese research universities (Lu et al., 2014). These scales tried to capture the quality of the interpersonal relationships or psychosocial atmosphere in the institution by asking students to rate the degree of the perceived supports from teachers and the cohesiveness among peers, and so on.

As examined by the widespread surveys and investigations, knowledge about the quantity and quality of college student social experiences has gradually improved. First, considerable efforts have been made to characterize students and institutions by referring to the variations in students' social interactions (Hu & McCormick, 2012; Pike & Kuh, 2005; Trowler, 2010). Coates (2007) conceptualized that student social and academic engagement are distinct constructs in both traditional and online campus-based contexts. He then proposed a four-quadrant typology aggregating and dividing students by their degrees of academic and social engagement. The four labels assigned to each group of students were intense (identified by a high level of social and academic engagement), collaborative (a high level of social and a low level of academic engagement), independent (a high level of academic and a low level of social engagement), and passive (a low level of both social and academic engagement) learners. Additionally, Coates (2007) realized that student engagement could change according to the environment. Statistics revealed that the number of collaborative students in the traditional situation was 345, but only 112 of them were online collaborators. In another typological study, Flynn (2014) found that both social and academic engagements exerted influences on the attainment of college students, but the degree of the impacts varied by student type.

Second, a body of literature has established correlations between interpersonal activities and desirable outcomes of students' academic learning and personal development. For instance, empirical evidence has supported that the frequency of students' social interactions in college

serves as a predictor of various aspects, such as academic motivation (Komarraju et al., 2010), achievement (Goguen et al., 2010), intellectual growth (Kim & Lundberg, 2016), psychological well-being (Kilgo et al., 2019), college satisfaction (Zhang et al., 2018), and persistence (Flynn, 2014). It was recognized that the psychosocial climate perceived by college students also positively affected many aspects of their cognitive and affective learning outcomes (Fraser, 2012; Wang et al., 2017; Yin & Lu, 2014).

Even though past endeavors have made remarkable contributions to the issue of student college and social experiences, there are at least two gaps in the current literature that deserve delving into the future research. The first research gap is that previous studies showed a strong preference for exploring the traditional campus environment, but the online experiences of college students are still an underexplored topic (Lundberg & Sheridan, 2015; Paulsen & McCormick, 2020; Redmond et al., 2018; Trowler, 2010). Some scholars have attempted to examine the validity of the measures assessing student social experiences in the online context (Coates, 2007; Redmond et al., 2018; Robinson & Hullinger, 2008). More investigations are needed to show the effects of online interactions on a spectrum of outcomes and to simultaneously compare them with those of traditional face-to-face interactions. Moreover, considering that student behavioral patterns may be incompatible in on-campus and online settings, college students' preferences for the traditional way of communication or networking through the Internet have yet to be discovered. Because student preferences may influence the engagement–outcome relationship (Flynn, 2014), it is necessary to distinguish whether student learning experiences and outcomes show different interactive patterns.

Secondly, since Astin (2012) pointed out that the environment can be the product of students' own actions and choices, there is apparently a lack of research on the link between the quantity and quality of students' social interactions. The number of interpersonal interactions and the students' perceptions of the psychosocial aspects of the environment have usually been explored as separate, independent variables (Astin, 2012). Further studies should examine the interactions simultaneously to identify to what degree the frequencies of students' traditional and online interactive behaviors can shape their perceptions of the psychosocial climate of the institution (e.g., teacher cognitive and affective support and student cohesiveness).

Two types of interpersonal interaction and their effects on student learning

Internet-based technology has irresistibly changed our way of communication, while bringing both convenience and challenges to learning and teaching. Two utterly different modes of communication have been pointed out: face-to-face synchronous and online asynchronous communication (Borup et al., 2011; Comer & Lenaghan, 2013; Watts, 2016). Face-to-face synchronous communication refers to the traditional way of communication that requires the simultaneous participation of teachers and/or students (Redmond, 2011). In contrast, online asynchronous communication,

occurring through the use of some computer or network techniques such as emails and discussion boards, promotes delayed interactions (Hrastinski, 2008). It has been demonstrated that the online asynchronous communication permits learning and teaching to occur anytime and anywhere (Redmond, 2011). In contrast, the face-to-face synchronous counterpart cannot provide such flexibility but ensures interactors to spontaneously exchange not only verbal messages but also nonverbal cues, such as tone of voice, gestures, facial expressions, and so on (Borup et al., 2011). The language use of online asynchronous communication is also different from that of the face-to-face synchronous format, as the former can be more accurate, complex, formal, and longer in utterances (Kitade, 2006; Wang & Woo, 2007).

As suggested by constructivist theorists such as Vygotsky (1978) and Bruner (1996), social interactions or communications serve as the basis of learners' construction of knowledge. However, scholars have not reached a consensus on the effectiveness of the two types of communication (Comer & Lenaghan, 2013; Roseth et al., 2011; Watts, 2016). The theory of social presence within the framework of Community of Inquiry doubted the quality of online asynchronous communication (Borup et al., 2011). Garrison et al. (2000) considered that social presence is individuals' ability to convey themselves as real people in a learning community, which is enhanced by thought, feeling, and humor sharing. However, with little or even no body language or emotional cues exchanged, social presence cannot be sufficiently established during asynchronous discussions (Borup et al., 2011). Therefore, online asynchronous interaction is less likely to instigate, sustain, and support academic progress, emotional connection, and student satisfaction, as compared with the conventional face-to-face interaction (Borup et al., 2012).

In his theory of transactional distance, Moore (1973) raised concerns about the communication efficiency of online interactions, although his attitude toward it was not so negative. The transactional distance theory posited that psychological and communication gaps are frequently experienced by individuals in online environments, but higher frequency of dialogues and learners' autonomy may reduce the misunderstandings (Moore, 1973). Its fragmented nature was identified as a central problem of online asynchronous discussions according to Moore (1973), but other scholars viewed it as a prominent advantage (e.g., Broadbent & Poon, 2015; Comer & Lenaghan, 2013; Hrastinski, 2008). They asserted that teachers and students may benefit from the convenience and autonomy of the asynchronous mode (Broadbent & Poon, 2015; Comer & Lenaghan, 2013). In addition, online asynchronous interaction enables students to have sufficient time to reflect upon the learning materials and to prepare for formal feedback, directly promoting students' cognitive development (Hrastinski, 2008).

Empirical studies in the past decade have also critically examined the pros and cons of face-to-face synchronous and asynchronous online interactions. It is suggested that face-to-face discussions were loosely structured but ensured that topics were covered and discussed

from divergent angles. In addition, face-to-face interactions contained more social and oral expressions and even used less dominant language as the medium (Hrastinski, 2008; Watts, 2016). In comparison, the asynchronous discussion threads more frequently used content-related utterances (e.g., asking or answering questions and sharing ideas), had more academic terms, and were longer and more difficult to read (Hrastinski, 2008; Kitade, 2006; Wang & Woo, 2007). Accordingly, asynchronous online interactions enabled students to generate more in-depth and thorough thinking about the materials (Watts, 2016).

Although the cognitive and social gains of asynchronous and synchronous interactions were repeatedly identified by past studies, somewhat conflicting evidence has been reported about using the two interactive types to enhance course outcomes and student satisfaction (Kunin et al., 2014; Paechter & Maier, 2010; Rockinson-Szapkiw & Wendt, 2015; Watts, 2016). For example, Strang (2013) found that the synchronous group collaborated more deeply and had higher project grades, while Duncan et al. (2012) reached the opposite conclusion. In terms of student satisfaction, some groups of students favored the synchronous mode due to its efficiency and content-richness, while others comparatively preferred the asynchronous interaction for its flexibility, autonomy promoting, and deep thinking stimulating, and it may reduce the feeling of uneasiness during face-to-face contacts (Comer & Lenaghan, 2013; Kunin et al., 2014; Paechter & Maier, 2010; Rockinson-Szapkiw & Wendt, 2015).

Both theories and empirical data unfold a complex mechanism of the impact from synchronous/asynchronous social interactions on students' learning experiences and outcomes. Past studies generally concurred with the social superiority of face-to-face synchronous interaction and the cognitive superiority of online asynchronous interaction, respectively (Hrastinski, 2008; Watts, 2016), in spite of the fact that the social and cognitive aspects of learning were also confirmed to be interrelated (Garrison et al., 2010; Rolim et al., 2019). However, the results linking various types of interpersonal interactions to student learning outcomes are still conflicting. More research is thus called for with regard to the following aspects.

First, the existing theoretical and empirical inquiries largely originated from or were conducted in Western countries. There is thus a need to turn to other parts of the world, especially the East Asian area. Their unique cultural heritage has shaped the learning styles of East Asian students who have been found to be passive or even silent learners in traditional classroom settings and who favor group cohesiveness and harmony (Sit, 2013; Wei & Li, 2013). Interestingly, these dual characteristics of the students could be contradictory factors in predicting the effects of face-to-face synchronous and online asynchronous interaction. In a qualitative research study, Tu (2001) found that, to avoid making mistakes and losing face, Chinese distance learners actually felt more comfortable with the asynchronous mode in which they were allowed to prepare their responses. However, as asynchronous communication has its limitation in establishing a highly connected

learning community, a number of studies have also found that this form of interaction was relatively inferior to the face-to-face mode in terms of achieving continuous, meaningful, and in-depth discussions, and even caused anxiety among East Asian students (e.g., Tu, 2001; Shu & Gu, 2018; Wang & Woo, 2007). To reach a better understanding of student social interaction in East Asian contexts, more studies should strive to unpack the collective preferences of students for face-to-face or online interaction, accompanied by identification of the cognitive and affective outcomes.

Second, the outcomes showing the effects of social interactions should be further expanded. The outcome variables used in past studies usually covered students' reflective thinking ability, social connectedness, examination grades, and course satisfaction. Some other factors could be included as well, especially the development of research skills of college students. As previously mentioned, the asynchronous interactions are commonly text-based and normally adopted formal and academic language (Kitade, 2006; Wang & Woo, 2007). There is not yet enough knowledge regarding whether online asynchronous interaction can facilitate students' academic language use such as their thesis writing skills.

Research questions

To address the existing research gaps, this study, adopting Astin's (1993, 2012) I-E-O model, attempts to establish a typology of Chinese students' preferences for social interactions and examines the effects of both face-to-face synchronous and online asynchronous interactions on students' learning experiences, outcomes, and personal development in Chinese research universities. Figure 1 shows the conceptual framework of this study.

In detail, the questions for this study to respond to are listed as follows:

1. What are the students' interactive patterns distinguished by the frequencies of student engagement in face-to-face synchronous and online asynchronous interactions?
2. Do students with different interactive patterns differ in their learning experiences, outcomes, and development?
3. Is student engagement in the two types of interactions significantly related to their learning outcomes and development of research skills?
4. Is student engagement in the two types of interactions significantly related to their perceived psychosocial learning environments in the institution?

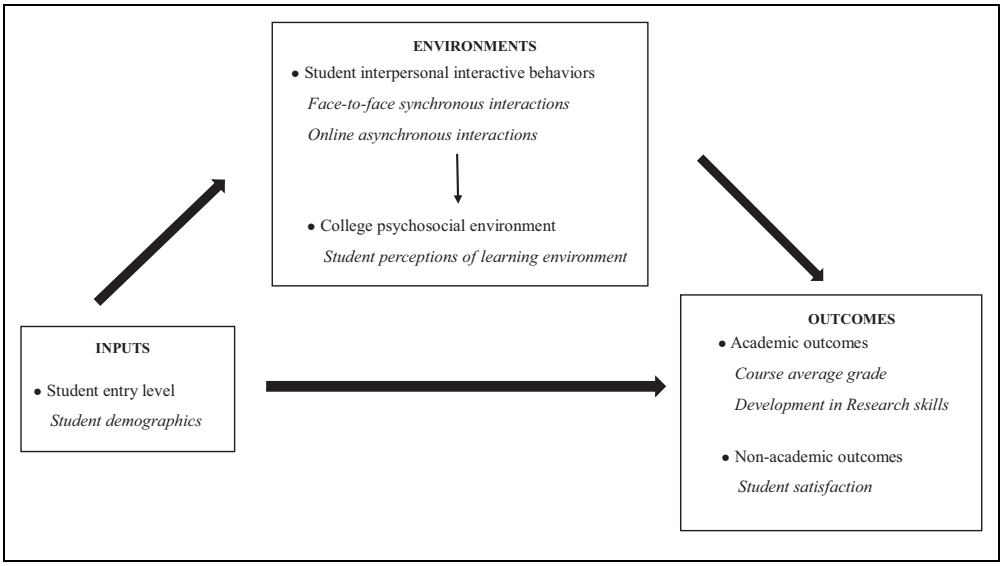

Figure 1. The conceptual framework of the present study.

Method

Participants and procedures

The study recruited a total of 3,999 undergraduates with highly diversified backgrounds in terms of year of study, area of study, socioeconomic status, gender, residence place, and experience of student leadership from a research university in Northern China. Table 1 presents the profile of the sample.

The participating university advanced online learning since 2000, being one of the earliest tryouts of distance education in China. An individual college was established particularly for arranging affairs and launching course or activities related with distance learning. In alliance with other HEIs, this university has selected some feature courses to present on both domestic and international e-learning platforms, such as MOOCs, XuetangX, and so on (Lu et al., 2018). Before and amid the COVID-19 pandemic, synchronous and asynchronous learning techniques were flexibly provided to facilitate online learning and interactions in the university.

A paper-based questionnaire survey was administered by the Higher Education Evaluation Center of the university to all undergraduates, excluding international students, at the end of the academic year after the courses of the Spring semester were finished. Students participated in the survey on a voluntary basis. Although the participants needed to fill in their personal identifier (i.e., students ID), they were ensured that their answers to the questionnaire would only be used for research purposes. Afterward, with permission, information about the participants' academic performance was collected from the Academic Affairs Office of the university. However, it was

Table 1. Demographic background of the respondents.

	N	%
Gender		
Male	2,709	67.74
Female	1,290	32.26
Year of study		
Year 1	1,155	28.88
Year 2	983	24.58
Year 3	824	20.61
Year 4	1,014	25.36
Year 5	8	0.20
Area of study		
Engineering	2,340	58.50
Bioscience	647	16.20
Social science	562	14.10
Natural science	279	7.00
Humanities	133	3.30
Arts	38	1.00
Family socioeconomic class		
Upper	12	0.30
Upper middle	138	3.45
Lower middle	1,540	38.51
Upper lower	1,378	34.46
Lower	931	23.28
Residence place		
Urban areas	1,499	37.48
County areas	950	23.76
Rural areas	1,550	38.76
Experience of student leadership		
Yes	1,775	44.39
No	2,224	55.61
Total	3,999	100.00

ensured that the individual student's responses to the questionnaire will not be disclosed to the university administrators, faculty members, or the public.

Measures

Student interactions in research university. A total of 8 items on a 6-point Likert-type scale ranging from *never* (1) to *frequently* (6) were extracted from the SERU questionnaire. Four items assessed

the frequencies of student engagement in face-to-face synchronous interactions (e.g., "I interacted with the teachers in/off class"). Another 4 items with the same measurement labels assessed the frequencies of student engagement in online asynchronous interactions (e.g., "I interacted with the teachers through email").

Student learning outcomes and development in research university. A total of 13 items on a 6-point Likert-type scale were extracted from the SERU questionnaire. Three factors of university students' learning outcomes and development were measured. The first factor, rated from *highly dissatisfactory* (1) to *highly satisfactory* (6), assessed students' overall satisfaction with their college lives (4 items; e.g., "How is your overall satisfaction with your academic experiences in college?"). The second factor measured student self-assessed computer and research skills at the entry and present stage (3 items for each stage; e.g., "Rate the degree of your competence in a computer-related skill"). The third factor, using points from *never* (1) to *frequently* (6), asked for information about student thesis completion (3 items; e.g., "I used five citations in a thesis").

Of particular note, one new variable was generated from the numeric distance of the computer and research skills between the entry and present levels, indicating student development in this aspect.

Learning environment scale. The 27-item scale adapted from Lu et al. (2014) was used to measure Chinese students' perceptions of the psychosocial learning environments in the research university. Seven 6-point Likert-type subscales, rated from *strongly disagree* (1) to *strongly agree* (6), were included: teacher academic assistance (3 items; e.g., "The teachers were interested in my question"), teacher affective support (4 items; e.g., "I think the teachers are friendly"), teacher emphasizing creativity (3 items; e.g., "The teachers encouraged students to be creative and make changes"), student autonomy (3 items; e.g., "Opportunities were given to pursue our own interests"), student cooperation (5 items; e.g., "I actively learned from other students"), student competition (3 items; e.g., "I think the competitions among peers were fierce"), and student sense of belonging (6 items; e.g., "I am proud to be a student of my university").

Academic performance. For the assessment of students' academic performance throughout the year, each participant's course average grade was collected from the Academic Affairs Office of the university. Considering the criteria for interpreting the grade are different across disciplinary areas, students' course average grades within each area of study were standardized into *z*-scores for further analyses.

Data analysis

The software of SPSS 23.0 was used to conduct data analysis. First, descriptive statistics (*M*, *SD*, *r*) and Cronbach's α coefficients of the variables were calculated.

Second, we conducted two-step cluster analysis to identify the clusters with similar features in students' preferences for face-to-face synchronous and online asynchronous interactions. The two-step cluster analysis is superior for revealing both pre-determined and natural groupings within the data set. Sequentially, one-way analysis of variance (ANOVA) and least significant difference (LSD) were used to analyze the between-cluster differences of student perceived psychosocial learning environments, student satisfaction, development of computer and research skills, completion of thesis, and course average grade. Third, we conducted hierarchical multiple regression analyses to test the effects of face-to-face synchronous and online synchronous interactions on student college experiences, learning outcomes, and development, after controlling for student demographic attributes. Two models were tested. The first regression model only included student demographic characteristics and, respectively, took the (sub-)scales of student perceived psychosocial learning environment, student satisfaction, development of computer and research skills, completion of thesis, and course average grade as the dependent variables for each unit of analysis. The second regression model additionally included student behaviors in face-to-face synchronous and online asynchronous interactions as the independent variables.

Results

Reliability and descriptive statistics

Table 2 presents the descriptive statistics and reliability of all factors and correlation coefficients between the factors. According to the statistics, all variables had acceptable reliability coefficients ranging from .70 to .84.

The descriptive statistics show that the students had an overall higher frequency of face-to-face synchronous interactions than online asynchronous interactions. Within the scope of student perceptions of learning environments, the highest mean score was found for teacher affective support, followed by student cooperation, student sense of belonging, student competition, teacher academic assistance, and teacher emphasizing creativity, while the score of student autonomy ranked lowest. Additionally, the scores show that the students were satisfied with their university experiences at a slightly positive level but could only complete their theses with no better than medium quality.

The correlation coefficients further indicated that the face-to-face synchronous interaction was generally more strongly related to student learning experiences, outcomes, and development than online asynchronous interaction. The only exception is the correlation between student autonomy and online asynchronous interaction ($r = .25$, $p < .01$), which was a little stronger than that with face-to-face synchronous interaction ($r = .22$, $p < .01$).

Table 2. Descriptive statistics, Cronbach's α, and correlation matrix of variables.

				Pearson *r*												
Dimension	Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
Interaction	1. Face-to-face synchronous interaction	2.81	0.90	**.80**												
	2. Online asynchronous interaction	2.61	0.79	.41**	**.76**											
Student perceived learning environment	3. Teacher academic assistance	3.93	0.78	.41**	.27**	**.70**										
	4. Teacher affective support	4.44	0.72	.24**	.08**	.65**	**.81**									
	5. Teacher emphasizing creativity	3.81	0.84	.29**	.27**	.59**	.52**	**.82**								
	6. Student autonomy	3.61	0.92	.22**	.25**	.50**	.38**	.53**	**.76**							
	7. Student cooperation	4.42	0.65	.27**	.10**	.45**	.51**	.39**	.30**	**.82**						
	8. Student competition	4.05	0.86	.08**	.00	.18**	.20**	.24**	.12**	.24**	**.84**					
	9. Student sense of belonging	4.09	0.83	.25**	.18**	.51**	.53**	.44**	.45**	.46**	.11**	**.83**				
Satisfaction	10. Overall satisfaction	3.63	0.79	.30**	.18**	.40**	.38**	.32**	.34**	.34**	.05**	.52**	**.78**			
Development in research and achievement	11. Computer and research skills	1.12	0.76	.21**	.16**	.15**	.19**	.14**	.10**	.24**	0.02	.24**	.19**	**.79**		
	12. Accomplishment of thesis	2.76	0.98	.41**	.40**	.21**	.11**	.19**	.15**	.18**	0.02	.16**	.19**	.24**	**.70**	
	13. Course average grade	0.00	1.00	.14**	.01	.06**	.07**	.03*	.00	.13**	.07**	.08**	.23**	.07**	.06**	—

Note. Cronbach's α values are entered on diagonal. Boldface values are Cronbach's alpha values that don't have significance level.
*$p < .05$, **$p < .01$.

Table 3. Results of the two-step cluster analysis and between-cluster differences on face-to-face synchronous and online asynchronous interactions.

			Face-to-face synchronous interaction			Online asynchronous interaction				
Cluster	*N*	%	*M*	*SD*	Level	*M*	*SD*	Level	Interactive pattern	Student label
1	1,308	32.71	2.09	0.53	Low	1.79	0.42	Low	Low interaction	Passive interactors
2	539	13.48	3.69	0.60	High	2.20	0.45	Low	Face-to-face synchronous interaction	Realistic interactors
3	1,446	36.16	2.59	0.44	Low	3.04	0.36	High	Online asynchronous interaction	Digital interactors
4	706	17.65	3.91	0.70	High	3.54	0.42	High	High interaction	Active interactors
Combined	3,999	100.00	2.81	0.90	—	2.61	0.79	—	—	—
ANOVA	—		$F(3,3998) = 2,256.92$, $p = .00$			$F(3,3998) = 3,778.86$, $p = .00$			—	—

Note. ANOVA, respectively, showed the between-cluster differences on face-to-face synchronous and online asynchronous interaction. ANOVA = analysis of variance.

Cluster analysis and one-way ANOVA

The results of two-step cluster analysis suggested that a four-cluster solution had good quality, as indicated by the Silhouette measure of cohesion and separation. The descriptive statistics (*M*, *SD*) and one-way ANOVA results (see Table 3) also indicated that the four clusters were separated well by the face-to-face synchronous and online asynchronous interactions.

Based on a further examination of the descriptive statistics, four labels were given to name each cluster of students: "active interactors," "realistic interactors," "digital interactors," and "passive interactors." As presented in Table 3, there were 1,308 cases (32.71%) in the first cluster of "passive interactors" characterized by low levels of both types of interaction, 539 cases (13.48%) in the second cluster of "realistic interactors" featuring a strong preference for face-to-face synchronous interaction, 1,446 cases (36.16%) in the third cluster of "digital interactors" characterized by strong preference for online asynchronous interaction, and the remaining 706 cases (17.65%) in the fourth cluster of "active interactors" featuring high levels of both types of interaction.

Subsequently, one-way ANOVA and LSD were conducted to detect the differences in student learning experiences, outcomes, and development among the four clusters. The ANOVA results showed significant between-cluster differences on all of the factors. The mean scores of student experiences, outcomes, and development (see Table 4) frequently demonstrated an order of the

Table 4. ANOVA and LSD results of between-cluster differences on college student learning experiences, outcomes, and development.

		Cluster 1 "Passive" (N = 1,308)		Cluster 2 "Realistic" (N = 539)		Cluster 3 "Digital" (N = 1,446)		Cluster 4 "Active" (N = 706)		One-way ANOVA		
Dimension	Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*	*p*	LSD*
Student perceived learning environment	Teacher academic assistance	3.61	0.80	4.13	0.75	3.93	0.68	4.34	0.73	170.92	.00	4 > 2 > 3 > 1
	Teacher affective support	4.33	0.73	4.60	0.68	4.38	0.69	4.62	0.73	39.06	.00	4 = 2 > 3 > 1
	Teacher emphasizing creativity	3.53	0.86	3.88	0.89	3.87	0.72	4.17	0.80	103.70	.00	4 > 2 = 3 > 1
	Student autonomy	3.32	0.93	3.60	0.93	3.70	0.82	3.94	0.93	82.86	.00	4 > 3 > 2 > 1
	Student cooperation	4.28	0.69	4.58	0.62	4.38	0.59	4.62	0.65	55.52	.00	4 = 2 > 3 > 1
	Student competition	4.01	0.93	4.19	0.87	4.00	0.78	4.10	0.87	7.51	.00	2 = 4 > 1 = 3
	Student sense of belonging	3.88	0.84	4.23	0.84	4.11	0.76	4.34	0.82	57.92	.00	4 > 2 > 3 > 1
Satisfaction	Overall satisfaction	3.39	0.80	3.79	0.79	3.62	0.71	3.94	0.8	86.52	.00	4 > 2 > 3 > 1
Development in research and achievement	Computer and research skills	0.97	0.72	1.21	0.75	1.11	0.74	1.39	0.79	51.91	.00	4 > 2 > 3 > 1
	Accomplishment of thesis	2.27	0.84	2.86	0.94	2.81	0.85	3.48	0.98	292.9	.00	4 > 2 = 3 > 1
	Course average grade	−0.04	1.01	0.19	1.00	−0.11	1.01	0.16	0.93	19.51	.00	2 = 4 > 1 = 3

Note. ANOVA = analysis of variance; LSD = least significant difference.

[a] $a > b$ indicates that the mean of cluster "a" is significantly greater than the mean of cluster "b"; $a = b$ indicates that the mean difference between cluster "a" and "b" is nonsignificant.

four clusters from highest to lowest as "active interactors" > "realistic interactors" > "online interactors" > "passive interactors." However, there is a different sequence for student autonomy, as ranked by "active interactors" > "online interactors" > "realistic interactors" > "passive interactors." Also, on student competition and course average grade, the mean scores followed the rank of "realistic interactors" > "active interactors" > "passive interactors" > "online interactors."

The LSD results in Table 4 indicated the difference level between each of two clusters. A consistent pattern is revealed that the "active interactors" significantly outperformed the "passive interactors" regarding all the factors. At the same time, "active interactors" showed better performance compared with both "realistic" and "digital interactors" on 7 of the total 11 factors. However, no significant difference was found on four of the variables between "active interactors" and "realistic interactors," namely, teacher affective support, student cooperation, student competition, and course average grade.

The means of "realistic interactors" exceeded "digital interactors" among 8 of the 11 factors, that is, teacher academic assistance, teacher affective support, student cooperation, student competition, sense of belonging, overall satisfaction, improvement of computer and research skills, and course average grade. Notably, on student autonomy, the score of "digital interactors" was significantly higher than that of "realistic interactors." Significantly better performance was also detected in "realistic interactors" and "digital interactors" when compared with "passive interactors." However, on student competition and average course grade, the differences between "passive interactors" and "digital interactors" were not significant.

Hierarchical multiple regression analysis

Table 5 indicates the results of hierarchical multiple regressions utilizing students' personal attributes and interactive behaviors to predict their learning experiences, outcomes, and personal development. In Model I, student demographic and other personal factors (i.e., student gender, year of study, area of study, socioeconomic status, residence place, and experience of student leadership) were included as the predictors. At this stage, the scores of F revealed that all the models were significant.

In Model II, factors of students' reported frequencies of face-to-face and online interactions were incorporated into the regression model. The scores of ΔF suggested that the effects of the two interactions were significant. The scores of ΔR^2 further indicated that for the subfactors of student perceived learning environment, the two interactions explained an additional 18% of the variance in teacher academic assistance, 12% in teacher emphasizing creativity, 9% in student autonomy, 7% in student cooperation, 6% in teacher affective support, 6% in student sense of belonging, and 1% in student competition. As for students' academic and developmental outcomes, the percentage

Table 5. Hierarchical multiple regression analyses predicting college student learning experiences, outcomes, and development.

Dimension	Dependent variable	Model	R^2	Adjusted R^2	ΔR^2	F	ΔF	Predictor for Model II	β	t
Student perceived learning environment	Teacher academic assistance	Model I	.02	0.02	.02	11.43**	—	Face-to-face synchronous interaction	.36	22.55**
		Model II	.19	0.19	.18	118.61**	432.72**	Online asynchronous interaction	.15	9.12**
	Teacher affective support	Model I	.01	0.01	.01	5.56**	—	Face-to-face synchronous interaction	.25	15.00**
		Model II	.07	0.07	.06	35.83**	125.57**	Online asynchronous interaction	−.02	−0.86
	Teacher emphasizing creativity	Model I	.02	0.01	.02	10.10**	—	Face-to-face synchronous interaction	.23	13.97**
		Model II	.14	0.14	.12	78.90**	281.03**	Online asynchronous interaction	.21	12.57**
	Student autonomy	Model I	.01	0.01	.01	7.69**	—	Face-to-face synchronous interaction	.15	9.20**
		Model II	.1	0.1	.09	58.13**	207.09**	Online asynchronous interaction	.23	13.42**
	Student cooperation	Model I	.02	0.02	.02	15.59**	—	Face-to-face synchronous interaction	.27	15.97**
		Model II	.09	0.09	.07	48.82**	145.14**	Online asynchronous interaction	−.01	−0.45
	Student competition	Model I	.03	0.02	.03	17.95**	—	Face-to-face synchronous interaction	.10	6.00**
		Model II	.04	0.03	.01	18.36**	19.09**	Online asynchronous interaction	−.02	−0.86
	Student sense of belonging	Model I	.03	0.02	.03	17.67**	—	Face-to-face synchronous interaction	.21	12.62**
		Model II	.09	0.08	.06	46.37**	129.09**	Online asynchronous interaction	.08	4.52**

(continued)

Table 5. (continued)

Dimension	Dependent variable	Model	R^2	Adjusted R^2	ΔR^2	F	ΔF	Predictor for Model II	β	t
Satisfaction	Overall satisfaction	Model I	.04	0.04	.04	26.13**	—	Face-to-face synchronous interaction	.26	15.83**
		Model II	.11	0.11	.07	62.77**	166.16**	Online asynchronous interaction	.04	2.48*
Development in research and achievement	Computer and research skills	Model I	.14	0.14	.14	111.61**	—	Face-to-face synchronous interaction	.17	10.71**
		Model II	.18	0.18	.03	107.08**	80.16**	Online asynchronous interaction	.04	2.27*
	Accomplishment of thesis	Model I	.10	0.10	.10	74.40**	—	Face-to-face synchronous interaction	.28	18.66**
		Model II	.27	0.26	.16	179.71**	445.73**	Online asynchronous interaction	.23	14.67**
	Course average grade	Model I	.03	0.03	.03	19.53**	—	Face-to-face synchronous interaction	.15	8.76**
		Model II	.05	0.05	.02	24.65**	38.85**	Online asynchronous interaction	−.08	−4.16**

Note. The hierarchical multiple regressions sequentially used two models as follows: seven variables representing student background information were included in Model I; additionally, face-to-face synchronous and online asynchronous interactions were examined in Model II.

*$p < .05$, **$p < .01$.

of variance explained by the two interactions ranged from 16% in the completion of the thesis, 7% in overall satisfaction, 3% in computer and research skills, to 2% in course average grade.

Specifically, the positive effects of online asynchronous interaction were demonstrated to be significant, but were much weaker than those of face-to-face synchronous interaction on four factors, namely teacher academic assistance ($\beta_{\text{face-to-face}} = .36$, $p < .01$; $\beta_{\text{online}} = .15$, $p < .01$), sense of belonging ($\beta_{\text{face-to-face}} = .21$, $p < .01$; $\beta_{\text{online}} = .08$, $p < .01$), overall satisfaction ($\beta_{\text{face-to-face}} = .26$, $p < .01$; $\beta_{\text{online}} = .04$, $p < .05$), and the improvements in computer and research skills ($\beta_{\text{face-to-face}} = .17$, $p < .01$; $\beta_{\text{online}} = .04$, $p < .05$).

Compared with the insignificant or negative effects of online asynchronous interaction, face-to-face synchronous interaction showed positive effects on student perceptions of teacher affective support ($\beta_{\text{face-to-faces}} = .25$, $p < .01$; $\beta_{\text{online}} = -.02$, $p > .05$), student cooperation ($\beta_{\text{face-to-face}} = .27$, $p < .01$; $\beta_{\text{online}} = -.01$, $p > .05$), student competition ($\beta_{\text{face-to-face}} = .10$, $p < .01$; $\beta_{\text{online}} = -.02$, $p > .05$), and course average grade ($\beta_{\text{face-to-face}} = .15$, $p < .01$; $\beta_{\text{online}} = -.08$, $p < .01$). In contrast, the online asynchronous interaction exerted equivalent positive effects with, or even superior positive effects over, the face-to-face interaction on three variables: student autonomy ($\beta_{\text{face-to-face}} = .15$, $p < .01$; $\beta_{\text{online}} = .23$, $p < .01$), teacher emphasizing creativity ($\beta_{\text{face-to-face}} = .23$, $p < .01$; $\beta_{\text{online}} = .21$, $p < .01$), and completion of thesis ($\beta_{\text{face-to-face}} = .28$, $p < .01$; $\beta_{\text{online}} = .23$, $p < .01$).

Discussion

The results of this study, after controlling for student demographics, revealed the positive effects of social interactive behaviors on students' learning experiences, outcomes, and development in a Chinese research university. By distinguishing face-to-face synchronous versus online asynchronous interactions, these results also led to an enhanced knowledge of the interactive patterns of Chinese college students. This study, in a comprehensive manner, uncovered the specific effects of the two types of interactions in Chinese HEIs as well. These results raised the following topics worthy of further discussion.

Students' interactive patterns and their college experiences

In line with Coates's (2007) approach, the results of the study suggested a typological model classifying the interactive patterns of Chinese college students into four groups. Four labels were used to highlight the features of the four groups of students, while the quantitative data depicted the distribution of student collective preferences for face-to-face or online interactions. The whole sample showed overall higher frequencies of face-to-face synchronous interactions as compared with online asynchronous interactions. When looking into each cluster of students, the reported means indicated that the engagement in face-to-face interactions was more frequent in "active," "realistic," and "passive interactors." However, over one third of the students (i.e., "digital

interactors") (36.16%) had developed greater preference for online asynchronous interactions. The results showed that although face-to-face interactions were favored by students on a large scale, many of the Chinese college students were accustomed to the online virtual environment. This is consistent with Tu's (2001) suggestion that, in the era of the Internet, Chinese students have begun to feel more comfortable with online asynchronous communication.

In a further examination, the descriptive statistics demonstrated that nearly one third of the college students were "passive interactors" (32.71%), while nearly one third appeared to have "active" (17.65%) or "realistic" (13.48%) interactive patterns. That is to say, a larger portion of the students were either uninterested in either type of interpersonal interaction (i.e., the "passive interactors") or preferred using asynchronous Internet technology to connect with others (i.e., the "digital interactors"), while less than one third actively engaged in face-to-face interactions. These findings corroborate some previous claims addressing the passive performance of Chinese students in conventional classroom settings (Sit, 2013).

As for the between-group differences in the experiences, outcomes, and developments, it could be concluded that "active interactors" had the greatest levels of achievement in college, followed by "realistic interactors," "digital interactors," and "passive interactors." Of particular note is the fact that the "active interactors" consistently outperformed the "digital" and "passive interactors," and the "realistic interactors" always had better performance than the "passive interactors." However, for some specific experience and outcomes variables, the differences between the "active" and "realistic interactors" were not significant. In addition, the "realistic interactors" scored lower than the "digital interactors" on student autonomy. Meanwhile, no difference was detected between the "digital" and "passive interactors" in terms of their course average grade. In other words, these results revealed a complex mechanism of how face-to-face synchronous and online asynchronous interactions influence college students' academic learning and personal development. Discussions specifically focusing on the roles of face-to-face synchronous and online asynchronous interactions in student learning are required, as specified in the next section.

The effects of two types of interpersonal interaction on student learning

The descriptive statistics of the study indicated the characteristics of student learning experiences and their degrees of achievement, satisfaction, and growth in computer and research skills. In line with some studies (e.g., Wang et al., 2017; Yin & Lu, 2014), the college learning environments in Chinese HEIs are featured by strong interpersonal connections, as reflected in the results that teacher support, peer collaboration, and student sense of belonging were all scored highly in the present study. Although there was a moderate level of teacher academic assistance and emphasis on creativity in Chinese HEIs, student autonomy was still least emphasized. Regarding the

satisfaction variable, the students on average had a slightly positive satisfaction with their college lives. They also showed fair developments in the ability of writing an in-depth thesis.

More importantly, it should be articulated how face-to-face synchronous and online asynchronous interactions accounted for students' perceptions of the learning environment, their learning outcomes, and personal developments. The results of the correlation and regression analyses explicated that face-to-face synchronous interactions yielded greater positive effects on student learning and made significant contributions to all the constructs of academic learning outcomes and development. As for students' perceived learning environments, face-to-face synchronous interactions were supportive to increase the level of teacher academic assistance. Moreover, it contributed to shaping an interpersonally connected and cognitively aroused environment in terms of teacher affective support, peer collaboration, students' feeling of belonging, and teachers emphasizing creativity. It was also positively associated with both the academic and nonacademic outcomes.

In contrast, the online asynchronous interactions were more helpful for motivating students cognitively, as indicated by its relationship with teachers' academic assistance and emphasizing creativity. However, it had a minimum or even no effect on the social aspects of the learning environment, which is evident in its association with teacher affective support, students' cooperation, competition, sense of belonging, and autonomy. Meanwhile, online asynchronous interactions had limited effects on students' learning achievement and development in research skills, except for student completion of thesis writing. In line with previous findings (Hrastinski, 2008; Kitade, 2006; Wang, & Woo, 2007), the positive effects on student thesis writing may be ascribed to the nature of online text-based communications, which are largely featured by formal, complex, written languages, and academic-related content.

When comparing the two interactive modes, the online asynchronous interactions at best reached a comparable influence on student learning with the face-to-face synchronous interactions, except student autonomy on which online interactions showed a greater effect. Our results lend credence to previous studies that doubted the emotional and social benefits that online asynchronous communications could afford (Borup et al., 2011, 2012; Watts, 2016). Meanwhile, consistent with some researchers (Hrastinski, 2008; Watts, 2016), this study also revealed the cognitive benefits of online asynchronous interactions, but these positive effects did not exceed those of face-to-face synchronous interactions. The pros and cons of the two types of interaction in facilitating students' cognitive and social development enhance our understanding of how to motivate Chinese college students. As frequently addressed, interpersonal connectedness and group cohesiveness are fundamental for student learning in China (Wei & Li, 2013). Moreover, the higher association between the online interactions and student autonomy supports previous claims that the online mode may encourage self-regulated and student-centered learning (Broadbent & Poon, 2015; Comer & Lenaghan, 2013).

Limitations and directions for future research

Four limitations of this study should be acknowledged. First, the findings of this study were built on a sample of Chinese students from one research university. Therefore, the results should be interpreted with care. Further studies should be conducted in culturally and contextually heterogeneous situations to ensure the validity of the four-cluster classification of students.

Following the SERU's approach, this study examined student online asynchronous interactions by asking the frequencies of their interactions with teachers and peers in text-based online communications, such as those through email. This research did not take different forms of online interactions into consideration, which represents the second limitation of the study. As the technology has evolved, the use of audios and videos to boost both asynchronous and synchronous communications has become more popular than ever (Borup et al., 2011, 2012; Watts, 2016). Noting that online video- and audio-based communications offer rich nonverbal and emotional cues in interpersonal interactions (Borup et al., 2012; Hrastinski, 2008), these interactive behaviors should be explored along with the text-based mode in future research.

Third, this research has a limitation in its focus on students' behavioral engagement in social interactions, which makes known little about what motivated these Chinese students to adopt conventional synchronous or online asynchronous interactions. Behavioral engagement is important, but the motivations underlying students' behavioral engagement are more meaningful (Yin, 2018). Therefore, more inquiries should concentrate on the motivations of different types of learners by addressing why there were relatively small portions of "active" and "realistic interactors" in Chinese HEIs, while there were a large number of students who were "digital" and "passive interactors."

Consistent with previous findings, the results of this study implied that Chinese learners may have their preferred ways of interactions in the digital era. Considering Chinese learners tend to be driven by the collectivistic culture and the fear of losing face (Tu, 2001; Wei & Li, 2013), the results reflect that many students may turn to be "digital interactors" for avoiding making mistakes in social interactions. However, with decreased immediate contacts with teachers or peers, they could possibly be less motivated and unsatisfactorily engaged as well. As the conclusion has not yet reached in this study regarding the issue, the characteristics of Chinese learners in online environments are worthy of more future inquiries.

Implications

The results of this study bring some implications for the improvement of learning and teaching in higher education. Considering the great educational benefits of traditional face-to-face interactions, we do not recommend that HEIs, especially Chinese HEIs, continue the full mode of online teaching and communications when the pandemic pressure is no longer serious. At least, the

transition to online teaching should be carried out gradually to ensure that all parties involved are ready for the new mode. As demonstrated in this study, online asynchronous interactions may help build a cognition-aroused and student-centered learning environment that is beneficial for developing students' thesis writing skills. We thereby strongly suggest that Chinese HEIs make use of the online asynchronous technologies in a blended format as a complement to the regular face-to-face interactions.

As further noted, more than one third of the college students showed their preference for the online asynchronous interaction; however, its effects on student learning were not so desirable, especially in forming interpersonal connections. This study also confirmed that many students were reluctant to engage in social interactions in college. To facilitate the learning of those "digital" and "passive interactors," improving the interactivity of campus online networks is highly recommended. As suggested by previous research, videos, audios, and emoticons could be applied for launching, maintaining, and extending online communications (Borup et al., 2011, 2012; Hrastinski, 2008). Simulating face-to-face scenarios, an easy and flexible adoption of these functions can support emotional expressions and group cohesiveness and increase the information density and the efficiency of information exchange.

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Contributorship

Hongbiao Yin was responsible for designing the research, commenting on the data analysis, reviewing and revising the manuscript, and responding to the reviewers' comments. Lian Shi contributed by analyzing the data, drafting the manuscript, and revising relevant sections of the paper.

Ethical approval

This research was carried out in full compliance of the ethical guidelines as approved by the Behavioural and Survey Ethics Committee, Chinese University of Hong Kong.

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