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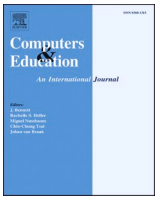

Interaction during online classes fosters engagement with learning and self-directed study both in the first and second years of the COVID-19 pandemic

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ABSTRACT

Maintaining students' learning engagement was a challenge in emergency online education during the pandemic. In this study, we investigated the predictors (social interaction) and outcomes (self-directed study) of engagement in online learning during the first and second years of the COVID-19 pandemic. First-year Japanese university students ($N = 1167$) enrolled in online classes during 2020 and 2021 responded to a questionnaire measuring perceived opportunities for social interaction during online classes, engagement with online learning, and extracurricular self-directed study time. Multi-group path analysis revealed that social interaction during online classes exhibited a positive indirect effect on self-directed study time through emotional and behavioral engagement with online learning. The positive indirect effect was significant in both the first and second years of the pandemic. The results suggest that increasing the number of opportunities for social interaction during online classes may exhibit spillover effects on learning outside the online classroom.

1. Introduction

The onset of the coronavirus disease 2019 (COVID-19) pandemic in 2020 precipitated innumerable changes in how people learned, worked, and interacted with one another (Galea et al., 2020). Higher education was profoundly impacted worldwide, as institutions were forced to switch from traditional face-to-face education to remote (online) emergency education to prevent the spread of the virus (Sahu, 2020). Accompanying other lifestyle changes, the switch to online education adversely impacted the mental health of students and faculty (Kita et al., 2022; Odriozola-González et al., 2020; Son et al., 2020), and disrupted learning (Aguilera-Hermida, 2020; Reyes-Portillo et al., 2022). Consequently, demotivation, disengagement, and dropout rates increased among students (Chiu et al., 2021; Donnelly & Patrinos, 2021).

Japan was no exception. The Japanese government declared a national state of emergency in April 2020. Most higher education institutions across the country decided to postpone the start of the academic year to May (the academic year usually starts in April in Japan) and to switch to online education for the new academic year. Accordingly, after May 2020, most university courses were held online (MEXT, 2020). The lack of interactions with other students and faculty, as well as the difficulty in using campus facilities,

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increased frustration and disengagement, especially among first-year students (Horita et al., 2021). Universities gradually returned to face-to-face course delivery in 2021, while maintaining the availability of online courses. In the current academic year (2022), higher education institutions across Japan held most courses face-to-face, though some universities continued delivering some of their courses online (MEXT, 2022b).

Despite the challenges and failures of remote emergency education (García-Morales et al., 2021), its implementation offered higher education institutions and their students the opportunity to discover online education's advantages (Aguilera-Hermida, 2020). Currently, an increasing number of faculty members and students are open to the possibility of blending face-to-face education with online courses (Kita et al., 2021), suggesting that online education is an enduring trend (Lockee, 2021). However, currently, online education is no longer an emergency solution to prevent the spread of the pandemic; hence, greater attention should be given to the quality of instruction. This study investigates the predictors and outcomes of learning engagement during emergency remote education in Japan. Reminiscing the lessons taught by emergency remote education, we might learn to be better prepared for a future wherein online education is the new normal.

1.1. Challenges to maintain students' online learning engagement

A primary challenge of emergency remote education was maintaining students' motivation and engagement (Teodorescu et al., 2022). Spending several hours facing the computer, students found it difficult to stay motivated and focused on the content of online courses (Oliveira et al., 2021). Lack of motivation and unfulfilled expectations pertaining to college life caused some students to contemplate taking leaves of absence or dropping out. Japanese students who named COVID-19 as the reason for dropping out of college during the 2021 academic year mentioned losing interest in studying as motive for their choice (MEXT, 2022a). Although the negative impact of emergency education on learning and satisfaction was less serious than initially predicted (Gonzalez et al., 2020; Lee et al., 2021), maintaining high engagement with learning during remote education is a challenging task.

Engagement with learning is considered the outward manifestation of a motivated student, representing the quality of a student's involvement with schooling, ranging from enthusiastic participation to apathic withdrawal (Skinner et al., 2009; Skinner & Pitzer, 2012). Learning engagement is defined as "constructive, enthusiastic, willing, emotionally positive, and cognitively focused participation with learning activities" (Skinner & Pitzer, 2012, p. 22). As engagement with learning is known to predict academic achievement (Lei et al., 2018) and retention (Álvarez-Pérez et al., 2021), fostering engagement among students is a core requirement of quality instruction (Coates, 2005). Even before the pandemic, education practitioners were keenly interested in how to keep students engaged with online learning and minimize attrition (Bond et al., 2020; Martin & Borup, 2022). The COVID-19-induced shift to online education in higher education institutions worldwide revived the discussion concerning the optimal solutions to foster learning engagement online, highlighting the importance of re-evaluating what is known regarding online learning engagement considering the unprecedented context in which emergency online education was being carried out.

In this study, we distinguish between two forms of engagement with learning: emotional and behavioral engagement (Skinner et al., 2009). Behavioral engagement refers to exerting effort, paying attention to, and persisting in academic tasks, while emotional engagement refers to the enthusiasm, enjoyment, and satisfaction experienced during the learning process (Skinner & Pitzer, 2012). Although the two are positively correlated and are known to predict learning outcomes, such as performance and retention (Lei et al., 2018), behavioral engagement tends to be more closely related to achievement than emotional engagement, whose effects on achievement are not as strong (Lee, 2014; Umemoto et al., 2016; Wang & Eccles, 2011). Nonetheless, emotional engagement may also be an important predictor of learning outcomes. Previous studies have demonstrated that emotional engagement may indirectly affect learning outcomes through behavioral engagement (Lee, 2014; Umemoto et al., 2016). In other words, enjoying studying (emotional engagement with learning) leads to exerting greater effort into academic tasks (behavioral engagement with learning), which eventually increases performance. These results suggest that fostering students' emotional engagement could be an effective strategy to promote effort, behavioral engagement, and achievement. Maintaining students' enthusiasm with respect to learning was among the most pressing challenges for lecturers during emergency remote education, when students had a hard time maintaining emotional engagement with learning (Wester et al., 2021).

1.2. Role of interaction in promoting learning engagement in online education

Online modes of delivery have certain limitations regarding how—and what types of—educational activities can be conducted. Forced to rapidly switch to online courses after the onset of the pandemic, lecturers encountered difficulties when trying to recreate the face-to-face educational experience (García-Morales et al., 2021). Being unable to share a common space with students, the biggest challenge was facilitating social interaction with students and among them to promote engagement (Azmat & Ahmad, 2022). Students felt isolated, alone, and bored, and the faculty complained about the difficulty of reaching students and maintaining two-way communication (Kita et al., 2021). Even before the pandemic, when asked for suggestions to improve the online educational experience, students expressed their desire for more interactive group activities, highlighting the need to increase opportunities for social interaction in online classrooms (Jones et al., 2012).

The importance of social interaction for learning has long been delineated by social constructivist theories, which propose that learning is a social process and that cognitive growth is most strongly promoted through discussion, conflict, and collaboration (Palincsar, 1998). Interactions between peers and between students and tutors are considered to promote learning engagement. For example, participating in social learning spaces where informal collaborative learning between students is possible has been shown to promote learning engagement and belonging (Matthews et al., 2011). Similarly, interactions with tutors in face-to-face classrooms

promoted emotional engagement and increased perceived learning (Sagayadevan & Jeyaraj, 2012). Self-determination theorists also acknowledge the importance of warm peer–teacher relationships in learning engagement (Furrer et al., 2014). Together, these results support social constructivist views on learning engagement, calling attention to the instructional power of social interaction.

Especially due to the difficulty in promoting it online, researchers have been particularly interested in how social interaction is linked to engagement and satisfaction (Jung & Choi, 2002; Kuo et al., 2014; Swan, 2001, 2002; Wang et al., 2022). Previous research has shown that interaction with instructors, as well as collaboration between participants in online courses, improve satisfaction and perceived learning (Abuhassna et al., 2020; Alqurashi, 2019). Furthermore, teaching presence and instructor scaffolding for interaction predict behavioral and emotional engagement in online learning (Cho & Cho, 2014). These studies suggest that instructors could reduce the disengagement and sense of isolation that some online environments induce by being present and providing students with opportunities for social interaction.

There is strong evidence that social interaction is desired by students and effective in promoting learning engagement online (Jones et al., 2012; Martin et al., 2020). However, most research on this topic was conducted before COVID-19 changed the way courses are delivered in higher education. There are two major differences in online learning before and during the pandemic. The first difference is choice: Online learning during the pandemic was an emergency response that students and faculty had no choice but to accept. Compared to students who willingly attended online courses before the pandemic, those who had to attend emergency online education could have experienced more difficulty keeping themselves motivated to learn. The second difference relates to social interaction opportunities outside the classroom. Before the pandemic, students enrolled in online courses could compensate for the lack of social interaction during class, with interaction outside the classroom. However, during the COVID-19 pandemic, students were also deprived of social interaction in their free time. Accordingly, social interaction during class in times of emergency online education could be a much more important factor in determining student engagement compared to pre-pandemic times, especially for freshmen who did not have an informal social network to rely on when the pandemic struck. Thus, our study aims to re-examine the effect of social interaction on learning engagement during emergency online education considering these differences, focusing specifically on the experiences of first-year university students.

Furthermore, by collecting data in both the first (2020) and the second (2021) years of the pandemic, we aim to explore whether the effect of interactive activities changes as students and faculty become used to online education and face-to-face social interaction becomes more frequent. Compared to the first year of the pandemic, when stay-at-home orders were in place, and students had no opportunities for social interaction either inside or outside the classroom, during the second year of the pandemic, campuses opened, some face-to-face classes were resumed, and opportunities to meet people outside the classroom increased. Accordingly, social interaction during online classes could have been more desired by students and a more important predictor of learning engagement in the first year of the pandemic, than in the following year. We aim to explore this possibility by comparing the responses of first year students admitted to the university in 2020 to those admitted in 2021.

1.3. Spillover effects of engagement with online learning: Does it increase self-directed study?

Although learning engagement is known to promote achievement in class, the goal of higher education surpasses obtaining good grades and graduating. Quality instruction in higher education should foster a wider interest in studying as well as self-directed learning skills, and out-of-class experiences are key to the development of autonomy and social maturation (Kuh, 1995). Therefore, in this study, we focus not only on engagement with learning in the online classroom but also on out-of-class self-directed study, and investigate whether online learning engagement exhibits spillover effects outside the classroom, promoting participation in extracurricular learning activities.

Self-directed learning skills have been deemed crucial in the present rapidly changing world (Morris, 2019b). Today, readiness for lifelong learning and autonomy in learning are required to adapt to modern world changes. Acquiring self-directed learning skills during college years could prepare students for complex careers, unexpected socioeconomic changes, and self-actualization (Morris, 2019a). Higher education can promote self-directed learning among students (Mentz et al., 2019). However, did emergency online education meet this standard, considering how unprepared both the faculty and students were for this change? In the current study, we aim to find an answer to this research question by investigating whether online learning engagement facilitated self-directed study beyond the online classroom during the pandemic.

1.4. The current research

Grounded in social constructivist theories of learning (Palincsar, 1998), the current research aims to investigate the predictors

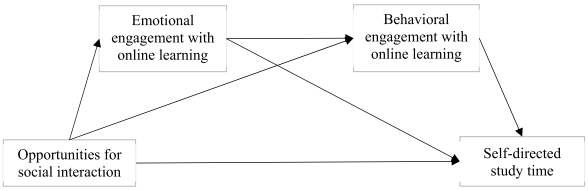

Fig. 1. Hypothesized multi-group (year 2020 versus 2021) path model.

(opportunities for social interaction) and outcomes (self-directed learning) of engagement in emergency online education during the first (2020) and second (2021) years of the pandemic, among first-year Japanese university students. The hypothesized path model is presented in Fig. 1.

First, in line with previous research on the effects of social interaction on engagement with learning, we expect that opportunities for social interaction predict emotional and behavioral engagement with online learning (Cho & Cho, 2014; Sagayadevan & Jeyaraj, 2012; Wang et al., 2022). Second, emotional engagement with online learning is expected to predict behavioral engagement, as suggested by previous research (Lee, 2014; Umemoto et al., 2016), thus being regarded a more distal predictor of learning outcomes in the model (i.e., self-directed study). Third, considering that collaborative learning (Mentz et al., 2019) and student engagement (Rashid & Asghar, 2016) are known to predict self-directed learning, we expect that opportunities for social interaction during online classes, as well as emotional and behavioral engagement with online learning, will have a positive effect on self-directed study time. Together, we hypothesized that opportunities for social interaction during online classes have an indirect effect on self-directed learning through emotional and behavioral engagement. Finally, we explore the role of measurement time (2020 versus 2021) using a multi-group path analysis to assess whether any differences exist in the effects between the first and second years of the pandemic.

2. Method

2.1. Participants

The participants were first-year students majoring in social sciences at University A—a national university located in the Tokyo metropolitan area. During the 2020 academic year, almost all classes at University A were conducted online to prevent the spread of COVID-19, whereas in 2021, both online and face-to-face classes were conducted. Data were collected twice: from December 2020 to January 2021 (targeting first-year students admitted to the university in April 2020) and June to July 2021 (targeting first-year students admitted to the university in April 2021). In 2020, 659 first-year students responded to the questionnaire (63.54% response rate), while in 2021, 508 first-year students participated (50.04% response rate). Among the participants, 341 majored in management, 324 in economics, 208 in law, and 294 in sociology. Although majoring in different subjects, first year students at University A are required to enroll in general education courses (such as foreign language, humanities, and science courses), and they are also encouraged to take courses from other departments, so most students enroll in similar courses during their first year. Age, gender, and other personal information (e.g., nationality) were not collected because of the ethical requirements of the university. However, according to publicly available statistical data, the male-to-female ratio of all first-year students at University A was 7/3, while the Japanese-to-non-Japanese ratio of all undergraduate students at University A was 9/1 at both time points.

2.2. Measures

2.2.1. Opportunities for social interaction during online classes

Five items measuring interaction opportunities during class were used (Kanaoka, 2015). Items were slightly modified to refer to online classes (e.g., 'In the online classes I have attended, pair work and group work activities were adopted'). Participants were asked to evaluate the online classes they had attended during the current semester. Items were measured on a Likert scale ranging from 1 (disagree) to 5 (agree). The one-factor model was tested through CFA using the R package *lavaan*, and a good fit was obtained after adding error correlations for similarly worded items (χ^2/df = 3.88, CFI = 0.993, TLI = 0.993, RMSEA = 0.050, 90% CI [0.022, 0.081], SRMR = 0.007). Measurement invariance for 2020 and 2021 was tested, and the results revealed that the scale had metric invariance across the two groups (see Supplemental material, Table S1). Internal consistency was high (2020 α = 0.91, 2021 α = 0.83); therefore, a mean score was computed.

2.2.2. Learning engagement

The Engagement with Learning Scale (Skinner et al., 2009; for the Japanese version, see Umemoto et al., 2016) was modified slightly to measure engagement with learning in online classes. The questionnaire comprises two subscales, Emotional Engagement (5 items; e.g., "Online classes are fun") and Behavioral Engagement (4 items for the Japanese version; e.g. "I try to do well in online classes"). Items are measured on a Likert scale ranging from 1 (disagree) to 5 (agree). The two-factor model was tested through CFA using the R package *lavaan*, and an acceptable fit was obtained after adding error correlations between same-factor items (χ^2/df = 6.83, CFI = 0.981, TLI = 0.967, RMSEA = 0.071, 90% CI [0.060, 0.082], SRMR = 0.028). Measurement invariance for 2020 and 2021 was tested, and the results revealed that the scale exhibited scalar invariance across the two groups (see Supplemental material, Table S2). Internal consistency was high for both subscales (emotional engagement 2020 α = 0.90, 2021 α = 0.89; behavioral engagement 2020 α = 0.87, 2021 α = 0.86); therefore, mean scores were computed for each.

2.2.3. Self-directed study time

Three original items were used to measure the time spent on self-directed study (e.g., time spent on self-directed study inspired by (though not directly related to) seminar and lecture topics; time spent discussing with friends and family topics related to various fields, including politics, economics, social sciences, law, business, and liberal arts; and time spent preparing for certification exams or foreign language qualification tests). Participants were asked to evaluate the average time spent per week on each of these activities during the current semester (0 to more than 10 h, with 0.5 h intervals). The total self-directed study time score (in hours) was

calculated by summing the three items.

3. Results

Descriptive statistics and correlations between the variables are presented in Table 1. Emotional and behavioral engagement in online classes were positively related to opportunities for interactive activities and self-directed study time.

Further, we investigated whether there were any significant differences between the 2020 and 2021 participants in their evaluation of interactive activities during online classes, online learning engagement, and self-directed study time. There were significant differences between 2020 and 2021 in students' evaluations of opportunities for social interaction during online classes ($t[1159] = 23.74$, $p < .001$). In 2020, first-year students reported more interactive opportunities than first-year students in 2021 (Table 1). Emotional engagement with online learning also differed between 2020 and 2021 ($t[1163] = 5.36$, $p < .001$), where the 2021 students reported higher emotional engagement than the 2020 students. There were no significant differences in behavioral engagement with online learning between students in 2020 and 2021 ($t[1163] = 0.86$, $p = .388$). Self-directed study time was significantly longer for the 2020 students than for the 2021 students ($t[1149] = 4.73$, $p < .001$).

To test the hypothesized multi-group (year 2020 versus year 2021) path model, the R package *lavaan* was used, and indirect effects were estimated using 5000 bootstrap samples. The results are shown in Fig. 2. At both time points, opportunities for social interaction during online classes significantly predicted emotional engagement with online learning. Furthermore, emotional engagement was positively associated with behavioral engagement, which positively predicted self-directed study time. The percentage of variance in self-directed study time explained by opportunities for social interaction during online classes and engagement in online learning was 6% in 2020 and 8% in 2021.

The indirect effect of opportunities for social interaction on behavioral engagement through emotional engagement was positive in both 2020 and 2021 (2020 estimate: $b = 0.181$, $SE = 0.02$, $p < .001$, 95% CI [0.136, 0.228]; 2021 estimate: $b = 0.157$, $SE = 0.02$, $p < .001$, 95% CI [0.107, 0.210]). The difference between the indirect effect for 2020 and that for 2021 was not significant ($b = 0.014$, $SE = 0.13$, $p = .914$, 95% CI [-0.244, 0.277]). Similarly, the indirect effect of emotional engagement on self-directed study through behavioral engagement was positive in 2020 and 2021 (2020 estimate: $b = 0.648$, $SE = 0.14$, $p < .001$, 95% CI [0.375, 0.944]; 2021 estimate: $b = 0.461$, $SE = 0.12$, $p < .001$, 95% CI [0.238, 0.737]). The difference between the indirect effect for 2020 and that for 2021 was not significant ($b = 0.187$, $SE = 0.19$, $p = .332$, 95% CI [-0.193, 0.560]).

Finally, the total indirect effect of opportunities for social interaction on self-directed study time through emotional and behavioral engagement was positive at both time points (2020 estimate: $b = 0.203$, $SE = 0.05$, $p < .001$, 95% CI [0.111, 0.314]; 2021 estimate: $b = 0.116$, $SE = 0.04$, $p = .002$, 95% CI [0.054, 0.202]). The difference between the indirect effect for 2020 and that for 2021 was not significant ($b = 0.087$, $SE = 0.06$, $p = .173$, 95% CI [-0.035, 0.215]).

4. Discussion

Focusing on the experiences of first-year Japanese university students, this study aimed to investigate the effect of social interaction during online classes on engagement with learning and extracurricular self-directed study time in the first (2020) and second (2021) years of the COVID-19 pandemic. We hypothesized that opportunities for social interaction during online classes would increase emotional engagement with learning, thus increasing behavioral engagement and self-directed study time. Furthermore, we explored whether this effect is stronger in the first year of the pandemic, when students lacked social interaction opportunities outside class.

First, when exploring differences in social interaction opportunities and engagement with learning between the first and second years of the pandemic, we observed that emotional engagement with learning was higher during the second year of the pandemic, compared to the first. Considering that first-year university students in 2021 had already experienced online education as high-school students, they could have been more prepared for online courses, and could have enjoyed them more. Furthermore, in 2021, campuses were open and face-to-face classes were resumed. Previous studies show that satisfaction with online education is higher when campuses are partially open, compared to when they are completely closed (Vollmann et al., 2022). Students could have enjoyed online education more when face-to-face courses were also available, due to greater diversity and more choice pertaining to the type of courses they could register for. Nonetheless, in terms of social interaction during online classes, there were fewer opportunities for social interaction during 2021 compared to 2020. It is possible that in the first year of the pandemic, when all classes were held online, lecturers attempted to recreate the face-to-face educational experience by including several interactive activities, but interactivity in the online class stopped being a priority in 2021, when face-to-face classes resumed. As a result, students perceived fewer opportunities for social interaction in 2021 than in 2020. However, considering that the scale measuring social interaction lacked scalar invariance,

Table 1
Descriptive statistics and correlations between variables.

	M (SD)	1	2	3	4	*M (SD)*
1. Opportunities for social interaction	3.5 (0.9)	-	.303***	.183***	.111*	2.1 (1.0)
2. Emotional engagement	3.0 (0.8)	.349***	-	.610***	.225***	3.2 (0.8)
3. Behavioral engagement	3.6 (0.9)	.189***	.569***	-	.276***	3.6 (0.8)
4. Self-directed study time (h)	3.0 (4.0)	.053	.134**	.237***	-	2.1 (2.7)

Note. Results for 2020 are presented below, and results for 2021 are presented above the diagonal.
*$p < .05$, **$p < .01$, ***$p < .001$.

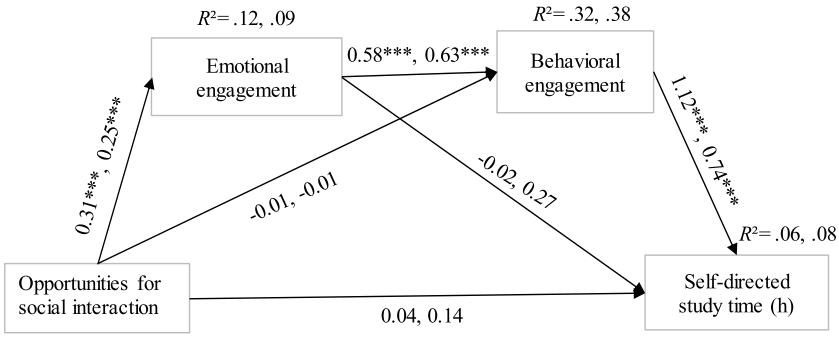

Fig. 2. Path model predicting self-directed study time by social interaction and learning engagement
Note. Unstandardized regression coefficients are presented. Coefficients presented first (left) represent the results for the year 2020, while those presented second (right) represent the results for the year 2021. $N = 1161$.
***$p < .001$.

the difference in students' evaluations of social interaction in 2020 and 2021 should be interpreted with caution.

Despite the higher emotional engagement with learning, and the lower social interaction during online classes in 2021, our hypothesized path model revealed that adopting interactive activities in online classes promoted learning engagement and self-directed study time, in both the first and the second years of the pandemic. Supporting socio-constructivist views of learning (Palincsar, 1998), our results showed that participants who reported that the classes they had attended had more group work, discussions, and presentations (social interaction), also reported that they enjoyed the classes more (emotional engagement), put more effort into studying for class (behavioral engagement), and spent more time studying topics unrelated to classwork (self-directed study time). We discuss these results and their practical implications.

In line with previous research suggesting that social interaction during class facilitates learning (Cho & Cho, 2014; Jung & Choi, 2002; Pavin Ivanec, 2022), the results of correlational analyses showed that more opportunities for social interaction during class were associated with more emotional and behavioral engagement, and with more self-directed study time (although only in 2021). However, when investigating these effects concurrently by testing the hypothesized path model, social interaction significantly predicted only emotional engagement with learning. This result suggests that social interaction is one way to promote students' enjoyment in class, so lecturers who want to keep their students interested and motivated to study could include interactive activities, such as group work and group discussions in their classes. Further, the results suggest that the effect of social interaction on behavioral engagement and self-directed study time is explained by emotional engagement, as social interaction has only an indirect effect on these two learning outcomes.

Replicating previous research on interaction in the face-to-face classroom (Sagayadevan & Jeyaraj, 2012), our study reveals the mediating role of emotional engagement in the online class: online social interaction facilitates learning because it makes learning fun, enjoyable, and captivating. Furthermore, when learning is fun, students work hard. In our model, emotional engagement with learning had an indirect effect on self-directed study time through behavioral engagement. This result replicates previous research (Lee, 2014; Umemoto et al., 2016), suggesting that emotional engagement with learning is a more distal predictor of learning behaviors, which works by promoting behavioral engagement. Studying may not always be enjoyable, but finding pleasure in studying is one way to motivate oneself to make consistent efforts. Accordingly, lecturers should monitor students' levels of enjoyment in class, as enjoyment can be an indicator of subsequent effort and performance.

The results of the multi-group path analysis revealed that the effect of social interaction during online classes on self-directed study time through engagement with online learning did not differ between the first and second years of the pandemic. Considering the lack of social interaction due to social distancing rules in 2020 (Lampraki et al., 2022), one could expect social interaction during online classes to be more appreciated by students, and thus, have a stronger effect on engagement in 2020 than in 2021. Nonetheless, the indirect effect of social interaction on self-directed study was as strong in 2021 as in 2020, suggesting the robustness of the results. A significant indirect effect of social interaction was observed even though opportunities for social interaction during online classes were fewer in 2021 than in 2020.

Our results suggest that even when few opportunities exist for social interaction during online classes, interactivity significantly predicts engagement and self-directed study time. Promoting social interaction during emergency remote education was a major challenge for lecturers (Azmat & Ahmad, 2022; Cavinato et al., 2021). As online classes will continue to be delivered alongside face-to-face classes post-pandemic, online lecturers must find ways to provide students with more opportunities for discussion, presentation, group work, role plays, and group debates. In fact, the online medium may provide new opportunities for engaging students, such as inviting guest speakers (Fulton, 2020), facilitating collaboration with students from other fields, universities, or countries (Vartiainen et al., 2022), cultural exchange programs employing VR technology (Liu & Shirley, 2021), or collaborative writing projects using team blogs or wikis (López-Pellisa et al., 2021). By exploiting these opportunities, lecturers could make their online classes more interactive, thereby fostering students' emotional and behavioral engagement with online learning, and helping them develop self-directed learning skills.

The most important contribution of this study to practice and research is that the effect of online social interaction appears to extend beyond promoting online classroom engagement. In our model, social interaction exhibited a significant indirect effect on self-

directed study time, suggesting that what happens during online classes has the potential to affect students' learning behavior outside the (online) class. This result hints to the fact that students' self-directed learning skills can be nurtured by changing how online classes are conducted. It is possible that social interactions during online classes made students aware of the diversity of others' opinions and perspectives, which aroused their curiosity and willingness to learn more about various topics outside the classroom (Hu & Kuh, 2003). Creating opportunities for students to learn what others think and strive toward also allows for social comparison and healthy competitiveness, which in turn may foster the desire for self-growth (Collins, 1996). Thus, lecturers should become more aware that how they structure their classes may influence students' learning behavior outside the classroom. Efforts to increase opportunities for social interaction during online classes may pay off in the long run, contributing to students' formation as autonomous learners.

4.1. Limitations and future directions

This study has several limitations with respect to self-report, correlational design, social desirability, and causal inference. The study was conducted during a global pandemic, and data was collected from only one Japanese university. In addition, the students in our sample were all majoring in social sciences. Online education could have been more difficult to implement, and students' learning engagement harder to maintain, in other domains, such as medical sciences and engineering, where laboratory and clinical practice are a central part of the curriculum. Therefore, future research should attempt to verify the generalizability of the findings to other student samples from within and outside Japan.

To test the replicability of our hypothesized model, future research might employ experimental designs that manipulate the degree of social interaction during online classes as well as more objective performance indicators (e.g., GPA). Although the data were collected at two time points, the cross-sectional design of this study cannot rule out cohort effects. Longitudinal studies should be conducted to investigate intraindividual variation. The results of our quantitative investigation also need to be verified and extended through qualitative research. The subjective experience of students during a global pandemic could be much more complex and idiosyncratic than the statistical model proposed in this research. Only through in-depth interviews, focus-groups and content analysis can we obtain insight into the subjective experience of engagement with learning during a time of crisis.

As for our model, we only focused on emotional and behavioral engagement, without investigating other forms of engagement, such as cognitive or social engagement (Fredricks et al., 2016), or the opposite of engagement, that is, disaffection (Skinner et al., 2009). Additionally, the Opportunities for Social Interaction Scale employed in our study did not distinguish between different types of interaction, such as learner-learner, learner-content, and learner-teacher interaction (Wang et al., 2022). Future research should examine how different types of interaction link with different types of engagement and disaffection. There are also several other factors which could influence engagement with learning and self-directed study that we did not investigate, or control for, in our model. Lecturer characteristics, such as readiness for online teaching (Cutri et al., 2020), students characteristics, such as self-regulated learning skills (Zhu et al., 2020), or course design features, such as the use of gamification (Tsay et al., 2020), could be included as possible predictors of online learning engagement in future research.

Finally, although the results support the view that social interaction during online classes is desirable and beneficial, over-generalization should be avoided. Previous research suggests that social interaction during online classes leads to more satisfaction and better learning, after which it brings no additional benefits (Mehall, 2021). Therefore, "the more the better" is not always the case. Furthermore, providing students with opportunities for social interactions is insufficient (Kreijns et al., 2003). Satisfaction and engagement are fostered by the quality of social interactions during class. Finally, social interaction should not be considered a panacea for promoting engagement with learning. Introverts, students with social anxiety, or those who prefer to work alone may find interactive courses burdensome and emotionally draining, which could negatively affect their engagement with learning (Chamorro-Premuzic et al., 2005; Hancock, 2004). Future research should also examine the individual moderators of the association between social interaction and engagement with learning to clarify whether some students may benefit from social interaction during class more than others.

Author statement

Claudia Gherghel, **Shoko Yasuda**, and **Yosuke Kita** contributed equally to the conceptualization, data collection, analysis and interpretation, as well as writing and review of the manuscript.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.compedu.2023.104795.

References

Abuhassna, H., Al-Rahmi, W. M., Yahya, N., Aman, M., Megat Zakaria, Z., Kosnin, A. B. M., & Darwish, M. (2020). Development of a new model on utilizing online learning platforms to improve students' academic achievements and satisfaction. *International Journal of Educational Technology in Higher Education*, 17–38. https://doi.org/10.1186/s41239-020-00216-z

Aguilera-Hermida, P. A. (2020). College students' use and acceptance of emergency online learning due to COVID-19. *International Journal of Educational Research Open, 1*, Article 100011. https://doi.org/10.1016/j.ijedro.2020.100011

Alqurashi, E. (2019). Predicting student satisfaction and perceived learning within online learning environments. *Distance Education, 40*(1), 133–148. https://doi.org/10.1080/01587919.2018.1553562

Álvarez-Pérez, P. R., López-Aguilar, D., González-Morales, M. O., & Peña-Vázquez, R. (2021). Academic engagement and dropout intention in undergraduate university students. *Journal of College Student Retention: Research, Theory & Practice*. https://doi.org/10.1177/15210251211063611

Azmat, M., & Ahmad, A. (2022). Lack of social interaction in online classes during COVID-19. *Journal of Materials and Environmental Science, 13*(2), 185–196.

Bond, M., Buntins, K., Bedenlier, S., Zawacki-Richter, O., & Kerres, M. (2020). Mapping research in student engagement and educational technology in higher education: a systematic evidence map. *International Journal of Educational Technology in Higher Education, 17*(2), 1–30. https://doi.org/10.1186/s41239-019-0176-8

Cavinato, A. G., Hunter, R. A., Ott, L. S., & Robinson, J. K. (2021). Promoting student interaction, engagement, and success in an online environment. *Analytical and Bioanalytical Chemistry, 413*, 1513–1520. https://doi.org/10.1007/S00216-021-03178-X/FIGURES/3

Chamorro-Premuzic, T., Furnham, A., Dissou, G., & Heaven, P. (2005). Personality and preference for academic assessment: a study with Australian university students. *Learning and Individual Differences, 15*(4), 247–256. https://doi.org/10.1016/J.LINDIF.2005.02.002

Chiu, T. K. F., Lin, T. J., & Lonka, K. (2021). Motivating online learning: the challenges of COVID-19 and beyond. *The Asia-Pacific Education Researcher, 30*(3), 187–190. https://doi.org/10.1007/S40299-021-00566-W

Cho, M. H., & Cho, Y. (2014). Instructor scaffolding for interaction and students' academic engagement in online learning: Mediating role of perceived online class goal structures. *The Internet and Higher Education, 21*, 25–30. https://doi.org/10.1016/J.IHEDUC.2013.10.008

Coates, H. (2005). The value of student engagement for higher education quality assurance. *Quality in Higher Education, 11*(1), 25–36. https://doi.org/10.1080/13538320500074915

Collins, R. L. (1996). For better or worse: the impact of upward social comparison on self-evaluations. *Psychological Bulletin, 119*(1), 51–69. https://doi.org/10.1037/0033-2909.119.1.51

Cutri, R. M., Mena, J., & Whiting, E. F. (2020). Faculty readiness for online crisis teaching: transitioning to online teaching during the COVID-19 pandemic. *European Journal of Teacher Education, 43*(4), 523–541. https://doi.org/10.1080/02619768.2020.1815702

Donnelly, R., & Patrinos, H. A. (2021). Learning loss during Covid-19: an early systematic review. *Prospects*, 1–9. https://doi.org/10.1007/S11125-021-09582-6/TABLES/3

Fredricks, J. A., Filsecker, M., & Lawson, M. A. (2016). Student engagement, context, and adjustment: addressing definitional, measurement, and methodological issues. *Learning and Instruction, 43*, 1–4. https://doi.org/10.1016/J.LEARNINSTRUC.2016.02.002

Fulton, C. (2020). Collaborating in online teaching: Inviting e-guests to facilitate learning in the digital environment. *Information and Learning Science, 121*(7–8), 579–585. https://doi.org/10.1108/ILS-04-2020-0116

Furrer, C. J., Skinner, E. A., & Pitzer, J. R. (2014). The influence of teacher and peer relationships on students' classroom engagement and everyday motivational resilience. *Teachers College Record, 116*(13), 101–123. https://doi.org/10.1177/016146811411601319

Galea, S., Merchant, R. M., & Lurie, N. (2020). The mental health consequences of COVID-19 and physical distancing: the need for prevention and early intervention. *JAMA Internal Medicine, 180*(6), 817–818. https://doi.org/10.1001/jamainternmed.2020.1562

García-Morales, V. J., Garrido-Moreno, A., & Martín-Rojas, R. (2021). The transformation of higher education after the COVID disruption: emerging challenges in an online learning scenario. *Frontiers in Psychology, 12*, Article 616059. https://doi.org/10.3389/fpsyg.2021.616059

Gonzalez, T., de La Rubia, M. A., Hincz, K. P., Comas-Lopez, M., Subirats, L., Fort, S., & Sachaid, G. M. (2020). Influence of COVID-19 confinement on students' performance in higher education. *PLoS One, 15*(10), Article e0239490. https://doi.org/10.1371/journal.pone.0239490

Hancock, D. (2004). Cooperative learning and peer orientation effects on motivation and achievement. *The Journal of Educational Research, 97*(3), 159–168. https://doi.org/10.3200/JOER.97.3.159-168

Horita, R., Nishio, A., & Yamamoto, M. (2021). The effect of remote learning on the mental health of first year university students in Japan. *Psychiatry Research, 295*, Article 113561. https://doi.org/10.1016/j.psychres.2020.113561

Hu, S., & Kuh, G. D. (2003). Diversity experiences and college student learning and personal development. *Journal of College Student Development, 44*(3), 320–334. https://doi.org/10.1353/CSD.2003.0026

Jones, B. D., Watson, J. M., Rakes, L., & Akalin, S. (2012). Factors that impact students' motivation in an online course: Using the MUSIC model of academic motivation. *Journal of Teaching and Learning with Technology, 1*(1), 42–58. https://doi.org/10.1111/J.14678535.2009.00993.X

Jung, I., & Choi, S. (2002). Effects of different types of interaction on learning achievement, satisfaction and participation in web-based instruction. *Innovations in Education & Teaching International, 39*(2), 153–162. https://doi.org/10.1080/14703290252934603

Kanaoka, M. (2015). Multi-faceted self, social constructivist context, and communication practice to promote learner autonomy. *JACET Journal, 59*, 53–73.

Kita, Y., Yasuda, S., & Gherghel, C. (2021). Faculty perspectives and opinions on online education. In *Working Paper Series Mori Arinori Institute for Higher Education and Global Mobility*. WP202101 https://arinori.hit-u.ac.jp/wp-content/uploads/2021/05/d5fad1b854733d23f49349b29f6bffa6.pdf.

Kita, Y., Yasuda, S., & Gherghel, C. (2022). Online education and the mental health of faculty during the COVID-19 pandemic in Japan. *Scientific Reports, 12*(1), 1–9. https://doi.org/10.1038/s41598-022-12841-x

Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: a review of the research. *Computers in Human Behavior, 19*(3), 335–353. https://doi.org/10.1016/S0747-5632(02)00057-2

Kuh, G. D. (1995). Out-of-class experiences associated with student learning and personal development. *The Journal of Higher Education, 66*(2), 123–155.

Kuo, Y. C., Walker, A. E., Schroder, K. E. E., & Belland, B. R. (2014). Interaction, internet self-efficacy, and self-regulated learning as predictors of student satisfaction in online education courses. *The Internet and Higher Education, 20*, 35–50. https://doi.org/10.1016/J.IHEDUC.2013.10.001

Lampraki, C., Hoffman, A., Roquet, A., & Jopp, D. S. (2022). Loneliness during COVID-19: Development and influencing factors. *PLoS One, 17*(3), Article e0265900. https://doi.org/10.1371/JOURNAL.PONE.0265900

Lee, J.-S. (2014). The relationship between student engagement and academic performance: is it a myth or reality? *The Journal of Educational Research, 107*(3), 177–185. https://doi.org/10.1080/00220671.2013.807491

Lee, K., Fanguy, M., Lu, X. S., & Bligh, B. (2021). Student learning during COVID-19: it was not as bad as we feared. *Distance Education, 42*(1), 164–172. https://doi.org/10.1080/01587919.2020.1869529

Lei, H., Cui, Y., & Zhou, W. (2018). Relationships between student engagement and academic achievement: a meta-analysis. *Social Behavior and Personality: International Journal, 46*(3), 517–528. https://doi.org/10.2224/sbp.7054

Liu, Y., & Shirley, T. (2021). Without crossing a border: exploring the impact of shifting study abroad online on students' learning and intercultural competence development during the COVID-19 pandemic. *Online Learning, 25*(1), 182–194. https://doi.org/10.24059/olj.v25i1.2471
Lockee, B. B. (2021). Online education in the post-COVID era. *Nature Electronics, 4*, 5–6. https://doi.org/10.1038/s41928-020-00534-0
López-Pellisa, T., Rotger, N., & Rodríguez-Gallego, F. (2021). Collaborative writing at work: peer feedback in a blended learning environment. *Education and Information Technologies, 26*, 1293–1310. https://doi.org/10.1007/s10639-020-10312-2
Martin, F., & Borup, J. (2022). Online learner engagement: Conceptual definitions, research themes, and supportive practices. *Educational Psychologist, 57*(3), 162–177. https://doi.org/10.1080/00461520.2022.2089147
Martin, F., Sun, T., & Westine, C. D. (2020). A systematic review of research on online teaching and learning from 2009 to 2018. *Computers & Education, 159*, Article 104009. https://doi.org/10.1016/J.COMPEDU.2020.104009
Matthews, K. E., Andrews, V., & Adams, P. (2011). Social learning spaces and student engagement. *Higher Education Research and Development, 30*(2), 105–120. https://doi.org/10.1080/07294360.2010.512629
Mehall, S. (2021). Purposeful interpersonal interaction and the point of diminishing returns for graduate learners. *The Internet and Higher Education, 48*, Article 100774. https://doi.org/10.1016/J.IHEDUC.2020.100774
Mentz, E., de Beer, J., & Bailey, R. (2019). *Self-directed learning for the 21st century - implications for higher education*. AOSIS. https://doi.org/10.4102/AOSIS.2019.BK134
MEXT. (2020). *Education in Japan beyond the crisis of COVID-19 - leave no one behind*. https://www.mext.go.jp/en/content/20200904_mxt_kouhou01-000008961_1.pdf.
MEXT. (2022a). *Gakusei no shuugaku joukyou (chuutaisha, kyuugakusha) tou ni kan suru chousa (reiwa 3 nendo matsu jiten)* [A study on college enrollment (dropout, temporary leave) (at the end of 2021 academic year)] https://www.mext.go.jp/content/20220603-mxt_kouhou01-000004520_01.pdf.
MEXT. (2022b). *Reiwa 4 nendo zenki no daigakutou ni okeru jugyou no jisshi houshintou ni kan suru chousa* [A study on university course delivery methods in spring 2022] https://www.mext.go.jp/content/20220603-mxt_kouhou01-000004520_02.pdf.
Morris, T. H. (2019a). Adaptivity through self-directed learning to meet the challenges of our ever-changing world. *Adult Learning, 30*(2), 56–66. https://doi.org/10.1177/1045159518814486
Morris, T. H. (2019b). Self-directed learning: a fundamental competence in a rapidly changing world. *International Review of Education, 65*(4), 633–653. https://doi.org/10.1007/S11159-019-09793-2
Odriozola-González, P., Planchuelo-Gómez, Á., Irurtia, M. J., & de Luis-García, R. (2020). Psychological effects of the COVID-19 outbreak and lockdown among students and workers of a Spanish university. *Psychiatry Research, 290*, Article 113108. https://doi.org/10.1016/j.psychres.2020.113108
Oliveira, G., Teixeira, J. G., Torres, A., & Morais, C. (2021). An exploratory study on the emergency remote education experience of higher education students and teachers during the COVID-19 pandemic. *British Journal of Educational Technology, 52*, 1357–1376. https://doi.org/10.1111/bjet.13112
Palincsar, A. S. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology, 49*, 345–375. https://doi.org/10.1146/annurev.psych.49.1.345
Pavin Ivanec, T. (2022). The lack of academic social interactions and students' learning difficulties during COVID-19 faculty lockdowns in Croatia: the mediating role of the perceived sense of life disruption caused by the pandemic and the adjustment to online studying. *Social Sciences, 11*(2), 42. https://doi.org/10.3390/socsci11020042
Rashid, T., & Asghar, H. M. (2016). Technology use, self-directed learning, student engagement and academic performance: examining the interrelations. *Computers in Human Behavior, 63*, 604–612. https://doi.org/10.1016/J.CHB.2016.05.084
Reyes-Portillo, J. A., Masia Warner, C., Kline, E. A., Bixter, M. T., Chu, B. C., Miranda, R., Nadeem, E., Nickerson, A., Ortin Peralta, A., Reigada, L., Rizvi, S. L., Roy, A. K., Shatkin, J., Kalver, E., Rette, D., Denton, E., & Jeglic, E. L. (2022). The psychological, academic, and economic impact of COVID-19 on college students in the epicenter of the pandemic. *Emerging Adulthood, 10*(2), 473–490. https://doi.org/10.1177/21676968211066657
Sagayadevan, V., & Jeyaraj, S. (2012). The role of emotional engagement in lecturer-student interaction and the impact on academic outcomes of student achievement and learning. *The Journal of Scholarship of Teaching and Learning, 12*(3), 1–30.
Sahu, P. (2020). Closure of universities due to coronavirus disease 2019 (COVID-19): Impact on education and mental health of students and academic staff. *Cureus, 12*(4), Article e7541. https://doi.org/10.7759/cureus.7541
Skinner, E. A., Kindermann, T. A., & Furrer, C. J. (2009). A motivational perspective on engagement and disaffection: Conceptualization and assessment of children's behavioral and emotional participation in academic activities in the classroom. *Educational and Psychological Measurement, 69*(3), 493–525. https://doi.org/10.1177/0013164408323233
Skinner, E. A., & Pitzer, J. R. (2012). Developmental dynamics of student engagement, coping, and everyday resilience. In S. Christenson, A. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 21–44). Springer. https://doi.org/10.1007/978-1-4614-2018-7_2/COVER.
Son, C., Hegde, S., Smith, A., Wang, X., & Sasangohar, F. (2020). Effects of COVID-19 on college students' mental health in the United States: interview survey study. *Journal of Medical Internet Research, 22*(9), Article e21279. https://doi.org/10.2196/21279
Swan, K. (2001). Virtual interaction: Design factors affecting student satisfaction and perceived learning in asynchronous online courses. *Distance Education, 22*(2), 306–331. https://doi.org/10.1080/0158791010220208
Swan, K. (2002). Building learning communities in online courses: the importance of interaction. *Education, Communication & Information, 2*(1), 23–49. https://doi.org/10.1080/1463631022000005016
Teodorescu, D., Ainur Aivaz, K., & Amalfi, A. (2022). Factors affecting motivation in online courses during the COVID-19 pandemic: the experiences of students at a Romanian public university. *European Journal of Higher Education, 12*(3), 332–349. https://doi.org/10.1080/21568235.2021.1972024
Tsay, C. H.-H., Kofinas, A. K., Trivedi, S. K., & Yang, Y. (2020). Overcoming the novelty effect in online gamified learning systems: an empirical evaluation of student engagement and performance. *Journal of Computer Assisted Learning*, 128–146. https://doi.org/10.1111/jcal.12385
Umemoto, T., Ito, T., & Tanaka, K. (2016). Relationships between regulation strategies, emotional and behavioral engagement, and academic achievement. *Japanese Journal of Psychology, 87*(4), 334–342. https://doi.org/10.4992/jjpsy.87.15020
Vartiainen, H., Vuojärvi, H., Saramäki, K., Eriksson, M., Ratinen, I., Torssonen, P., Vanninen, P., & Pöllänen, S. (2022). Cross-boundary collaboration and knowledge creation in an online higher education course. *British Journal of Educational Technology, 53*(5), 1304–1320. https://doi.org/10.1111/BJET.13186
Vollmann, M., Scheepers, R. A., Nieboer, A. P., & Hilverda, F. (2022). Study-related wellbeing, behavior, and attitudes of university students in The Netherlands during emergency remote teaching in the context of COVID-19: a longitudinal study. *Frontiers in Psychology, 13*, 7732. https://doi.org/10.3389/FPSYG.2022.1056983/BIBTEX
Wang, Y., Cao, Y., Gong, S., Wang, Z., Li, N., & Ai, L. (2022). Interaction and learning engagement in online learning: the mediating roles of online learning self-efficacy and academic emotions. *Learning and Individual Differences, 94*. https://doi.org/10.1016/J.LINDIF.2022.102128
Wang, M.-T., & Eccles, J. S. (2011). Adolescent behavioral, emotional, and cognitive engagement trajectories in school and their differential relations to educational success. *Journal of Research on Adolescence, 22*(1), 31–39. https://doi.org/10.1111/j.1532-7795.2011.00753.x
Wester, E. R., Walsh, L. L., Arango-Caro, S., Callis-Duehl, K. L., & Danforth, D. (2021). Student engagement declines in STEM undergraduates during COVID-19-driven remote learning. *Journal of Microbiology & Biology Education, 22*(1). https://doi.org/10.1128/jmbe.v22i1.2385. ev22i1.2385.
Zhu, Y., Zhang, J. H., Au, W., & Yates, G. (2020). University students' online learning attitudes and continuous intention to undertake online courses: A self-regulated learning perspective. *Educational Technology Research & Development, 68*(3), 1485–1519. https://doi.org/10.1007/S11423-020-09753-W