



# Online education in design disciplines: factors influencing the interactive experience of group learning

Lei Mao<sup>1,2,3</sup> · Francisco Queiroz<sup>1</sup>

Accepted: 17 January 2024 / Published online: 28 February 2024  
© The Author(s) 2024

## Abstract

There has been much previous research into online group learning, but they have not been aware of or focused on the challenges that design disciplines encounter in terms of interaction when moving to online delivery. This qualitative study comprised 3 participatory design workshops and 22 one-to-one interviews that included a total of 34 teachers and students from the School of Design at the University of Leeds. Participants reported the challenges and feelings they encountered in online group learning during the COVID-19 pandemic. The study found that the interactive experience of group learning is mainly influenced by the size of the group, the layout of the platform interface, the teacher's management style and the conflict within the group, with more far-reaching discussions providing specific questions and subtle suggestions. The article's findings can inform future strategies for online group learning for students and teachers of design disciplines in design higher education institutions.

**Keywords** Group learning · Design education · Online synchronous education · Interaction · Design disciplines

## Introduction

### Research background

Group learning has long been a common pedagogical approach to teaching and learning in all disciplines (Gerry et al., 2006). Collaborative group design based on design projects is also widely used in daily instructional activities in design disciplines, aiming to develop students' divergent and convergent thinking (Yilmaz & Daly, 2016). It emphasizes

---

✉ Lei Mao  
maolei98@outlook.com

Francisco Queiroz  
F.Queiroz@leeds.ac.uk

<sup>1</sup> School of Design, University of Leeds, Leeds LS29JT, UK

<sup>2</sup> Design School, Xi'an Jiaotong-Liverpool University, Suzhou 215123, China

<sup>3</sup> Institute of Population Health, University of Liverpool, Liverpool L693GF, UK

the exercise of cooperation between students in the group and creates a relaxed and facilitated discussion (interactive) environment that allows students to relax emotionally (Davis, 2009). In traditional education, group learning aims to reduce student interaction barriers and provide a convenient platform for communication (Barnes, 1992). After the teacher has given the task in class, the learners are randomly divided into small groups, and the group members divide their learning and discussion around the task. The teacher acts as a guide during the process giving the different groups the necessary guidance and monitoring the progress of the discussion (Miller & Hertz-Lazarovits, 1992). Students' ideas about the topic being discussed in small groups, and by refining and complementing each other's views, individual members can develop more perspectives on the problem, resulting in a unified interpretation that encompasses a variety of thinking perspectives (Bargh & Schul, 1980; McMahan et al., 2016). In the process of interaction, students try to consider the limitations of others' perspectives and justify their own positions in order to get their own views adopted by other members, and they develop their knowledge of the research topic at more levels and eventually reconstruct their own understanding (O'Donnell et al., 2006). Through group learning, students are able to develop their collaborative skills effectively, ultimately achieving high-quality delivery of tasks and a deep understanding of the research theme.

The rapid expansion in the scale of online education initially stemmed from the Coronavirus pandemic (Cutri et al., 2020). Although most higher education institutions worldwide have adapted delivery modes to face-to-face delivery, the online education model continues to be used in many programmes as a hybrid format (Rosa & Ferreira, 2023). In order to achieve the same level of interaction between teacher and student as in traditional face-to-face classes, it is common for institutions to implement online teaching methods based on synchronous delivery (Adedoyin & Soykan, 2020; Al Fadda, 2019). Most teaching institutions in design disciplines include a synchronous delivery-based group teaching component in their teaching activities (Godfrey et al., 2017). Videoconferencing offers a virtual space for direct communication across geographical boundaries, where content is delivered simultaneously, giving participants a condition of direct communication, guaranteeing them the convenience of direct communication and thus becoming a preferred teaching strategy (Davies et al., 2012; Ruiz et al., 2006). Current mainstream video-based synchronous distance learning platforms, such as Teams, Zoom and Ding talk, all of whose products currently offer real-time delivery for group learning (Cheung, 2021; Liu & Huang, 2020; Romig & Alves, 2021). However, this type of interaction reduces the opportunity for communication between course participants (Ali & Smith, 2015), and the process can be influenced by networks and devices, making it difficult for either individual students or groups to regulate their own learning (Bolliger & Martin, 2018; Malmberg et al., 2015). Since the end of the restrictions imposed by the Covid-19 pandemic, face-to-face teaching has once again become the norm in higher education institutions. However, experiences gained throughout the years of 2020 and 2021 have been useful in informing hybrid practices (such as online supervision and practical sessions), as well as contributing to the expertise required for developing new fully online programmes.

Group learning necessitates participants collaborating and relying on one another to perform learning tasks, and the collaboration process necessitates individual or group supervision; yet, supervision in online learning environments appears to be more difficult (Järvelä & Hadwin, 2013). Many educators report struggling to maintain classroom interactions with learners and manage instruction due to a lack of experience with online teaching (Moser et al., 2021). The only contact point between teachers and students is the screen, with the internet as the link (Blitz, 2013). Because the teacher cannot assist

observation through nonverbal behaviors such as visual afterimages and gestures as in traditional teaching scenarios, it is not easy to keep track of all group discussions at the same time, and forms of interaction between students and the teacher are reduced (MacMahon et al., 2020). Identifying and assessing learner status poses a significant challenge for educators (Sellahewa, 2011). Furthermore, many students turn off the camera during multi-person sessions due to network quality and personal factors, making it even more difficult for teachers to assess student participation in the classroom (Cole et al., 2021). Many researchers have realized that online delivery approaches present new challenges and opportunities for group learning and explore how to bring online learning groups to a level of quality similar to traditional face-to-face instruction (AbuSeileek, 2012; Godfrey et al., 2017; Jahng et al., 2010; Kim, 2013; Le et al., 2018; MacMahon et al., 2020; Saldanha et al., 2021).

Given that group learning is already widely used and plays an essential role in the daily instruction of design disciplines (Han et al., 2022). Its challenges and opportunities in transitioning to a distant online delivery format are worth investigating further. This study aims to identify the factors that affect the quality of interaction in group learning in design disciplines in an online education format from a stakeholder's perspective through the simultaneous implementation of a dual-track research methodology. It concludes with specific recommendations based on the findings of the qualitative study to help instructors of design disciplines to deliver online group learning better and increase students' interactive experiences of online courses.

## Theoretical background

### Design education

Design education is often focused on problem-solving, through which design practice is, itself, a learning method within what was once described as 'designerly ways of knowing', distinct from traditional sciences and humanities (Cross, 1982); similar to, yet distinct from, traditional research processes, (Cross, 1993; Farrell & Hooker, 2013). It is, by nature, highly interdisciplinary, collaborative, and reliant on verbal and visual modes of expression (Frascara, 2017)—and occasionally applied to disciplines other than design (Glen et al., 2014). A common feature of education in the design disciplines is the combination of teaching practical skills and theoretical expertise, often prefaced by theoretical knowledge, which is later reflected upon, validated, and explored through practice (Rosa & Ferreira, 2023). In higher education design discipline, learners spend most of their time in a design studio learning through a project format (Crowther, 2013; Fewella, 2023) The studio is divided into learning areas (Green, 2005), and then learners are assigned to a certain group size, social and collaborative skills are emphasized in the educational process (Yorgancioğlu & Tunali, 2020), and learners "interaction" is used to develop their perspectives and improve their practical skills (Alhusban et al., 2022), instructors move around the different areas and provide guidance and experience to the learners based on feedback (Boling & Smith, 2014), and continually contribute to the learners' ability to become independent designers.

Studio-based teaching process is not a fixed linear model (for example, testing students' mastery of knowledge through fixed exam questions) (Rosa & Ferreira, 2023), but rather a dynamic and interactive model of teaching and learning (Dannels & Martin, 2008), where

the process is subject to the dynamics of the project's development and the progress of the discussion. The educational methodology of the design discipline can therefore be summarized as a project-based, open-ended, inspirational learning environment that needs to be implemented in a certain space, with an emphasis on simultaneous interaction between all parties to develop learners' professional skills. "Interaction" can be defined as a process in which two or more parties interact with each other, both physically and emotionally, in terms of people, forms, functions, and technologies (Kolko, 2011). As such, "interaction" is recognized as an important source of experiential sensation in design education (Ceylan et al., 2021), and is where the challenge of moving from a face-to-face to an online format lies. In this study, "interaction" can be categorized into two main types. One type is interpersonal interaction, which points to peer, instructor-learner, and group exchanges in the design studio (Asadpour, 2021; Eren et al., 2023); and the other type is technologically mediated interactions, which include interactions between learners and digital devices, as well as interactions between learners and technologically-presented learning resources and learning environments (Jones et al., 2021).

### **Interaction for distance learning**

The definition of "interaction" in distance education and the necessity of assessing it has been hotly debated (Hillman et al., 1994). As early as the late 1980s, Moore (1989) identified three general types of interaction in web-based distance learning: learner-instructor interaction, learner-instructional content interaction (books, instructional videos, etc.), and learner-to-learner interaction (within groups), i.e. the process by which students express their own opinions on a topic of study and seek consensus among themselves. Building on this, Hillman et al. (1994) argue that the interactive interface of the device is the medium for distance learning and therefore suggest that online teaching should also include learner-device interface interaction as a fourth dimension. Catt et al. (2007) believe that the quality of interaction is influenced by the rapport and perceived competence between the teacher and the student, i.e. whether both partners can express themselves easily and whether the other understands the meaning of what they are saying. Kaufmann et al. (2016) also define this behaviour as one of the main factors that constitute the atmosphere in the classroom. Interaction in the online classroom does not simply refer to a discussion; it is passing information to each other (Hernández-Nanclares et al., 2017), information that contains theoretical knowledge, practical skills, insights and questions. Moreover, certain embodied elements have significant importance in face-to-face interaction, such as gaze, gesture, and speech (Oak & Lloyd, 2016), and might suffer in their transposition to online environments. Engagement is described in the process as one of the critical indicators of the quality of the interaction, and it is used to assess the extent to which students are actively learning (Vonderwell & Zachariah, 2005). In general, "interaction" is considered to be a major factor in the learning experience, both in traditional face-to-face teaching and today's internet-based teaching (Holmberg, 2020).

### **The role of group learning in the instruction of design disciplines**

In contrast to most disciplines, the teaching process in design disciplines involves not only theoretical knowledge but also practical skills (Qin & Li, 2020). To develop competencies in this field, online teaching in the design discipline includes many courses, with lectures commonly used to teach students theoretical knowledge and seminars and

workshops used to develop student's practical skills. However, the excessive number of students in a large classroom imposes limitations on interaction with each other, and controlling the number of participants in the classroom is thought to increase student engagement (Kim, 2013). The specific impact of student numbers on online instruction will be discussed later in this literature review. In response to this situation, assigning a certain number of students to different learning groups is a common strategy used by higher education institutions in various countries to teach design subjects (Zimmerman, 2012). The significance of group learning is that it is precise in scope, filters out information that may have a negative impact and allows students to form a small group, facilitating a more relaxed discussion to enhance participation in the course (Saldanha et al., 2021). The coating on learning assignments also unconsciously increases student performance (Kurucay & Inan, 2017; Qu et al., 2020), and student's capacity to think about theory and use professional software is highly practised. Moreover, the discussion process (Interaction) inevitably brings about some cognitive conflict, which is the driving force behind the development of higher-level learning and reasoning (Webb, 2009). After completing group work, students usually have a deeper understanding of the topic of study (Frisby & Martin, 2010), and, in the case of design disciplines, this means that high-quality design work or creative design is produced.

## Different types of interaction in online group learning

### Interaction between teachers and students

The academic community is made up of the interactions between students and teachers (Vrasidas, 2000). Online learning groups transform what was once a decentralised point-to-point interaction between teacher and student into a point-to-group interaction (Saldanha et al., 2021). Active learning is a broad general term for teaching methods and principles that usually involve collaboration between the student and the teacher (Faust & Paulson, 1998). The instructor, as a facilitator, can effectively contribute to the student learning experience by participating appropriately in online student-group interactions and giving guided prompts based on the direction of the discussion (Shea et al., 2010). Group learning is usually built on synchronous video conferencing in the case of online delivery, with the device's screen serving as the main window of engagement, resulting in a single medium of contact between teacher and student (Blitz, 2013). Group instruction in design disciplines often uses small design projects as the guiding task (Durling et al., 1996). Thompson and Ku (2006) suggested that project-based group learning should focus more on enhancing communication between students, but that when team members fail to reach a consensus among themselves, they often give up on more in-depth discussions, with the teacher taking on the responsibility to help and encourage learners to remain engaged in group interaction (Stepanyan et al., 2014). Summarising previous research, Frisby and Martin (2010) found that interpersonal relationships and the classroom environment can significantly influence the desire to interact with each other and with the teacher, and also noted that teachers have the primary responsibility for building an environment for classroom discussion. They encourage teachers to create a relaxed and interactive environment where learners feel very close to the teacher, which facilitates them to share their ideas.

## Interaction among students

Interaction between students in online courses is often based on group collaboration, which is central to student interaction (Jahng et al., 2010) and is manifested in the perception of a collaborative environment (Dwyer et al., 2004). Mayende et al. (2014) consider collaborative learning interaction between students and that online group education is only coordinated through technology. The purpose of the interaction is to complete the learning tasks issued by the teacher, and the students discuss with each other to continuously narrow the gap between members' opinions and finally have a unified understanding of the problem. Jung et al. (2002) also suggest that the quality of peer interaction in distance learning is an essential indicator of student satisfaction with the course. Frisby and Martin (2010) believe that student interaction in small groups is essentially an act of interpretation whereby members benefit from each other's understanding of the task as they explain it to each other. Maintaining the quality of peer interaction is, therefore, a vital learning strategy (Bolliger & Martin, 2018). According to Hernández-Nanclares et al. (2017), the act of crossing boundaries in group learning, in which some students in one group extend their interaction to members of other groups, helps to break up the relatively homogeneous discussion environment within the group, allowing for an increase in the number of touch points for interaction, which can improve the overall quality of the group discussion.

## Interaction between students and learning resources

Academic interaction begins when students receive learning materials from the teacher (Moller, 1998), which is one of the primary forms of online education (Vrasidas, 2000). Similar to traditional instruction, learning resources in online education contain videos, e-texts, audio, web links and software files (Ruiz et al., 2006), the difference being that they are all delivered online via the internet. Instead of obtaining a paper version for each individual (group) as in traditional teaching, groups of students can see documents simply by clicking on links or files, improving internal student debates' efficiency. Zimmerman (2012) shows that learners' frequency of interaction and familiarity with the content of a course is positively correlated with the quality of the final course completion by using the grades obtained from students' participation in the online course as an assessment factor. It is undeniable that online education has made the transfer of some instructional resources (digital files) more efficient and convenient, and the enhanced efficiency of resource transfer has provided favourable support for online group learning (Zhang et al., 2019). The teaching of design subjects is based in part on the support of electronic devices, such as using professional software on computers to output design solutions. The software's collaborative character helps improve student interaction with knowledge (Cheung, 2021), and teachers and students can use online collaborative software to carry out synchronous or asynchronous teaching and learning activities. Adobe, for example, which develops design software, has also focused in recent years on solving the problem of accessing and transferring file resources in its software by transferring design files to the cloud so that group members with access can access the resource remotely on different devices and can perform interactive actions including editing and commenting (Adobe, 2021).

## Factors affecting the quality of online group learning

### The impact of the number of group members

Many types of research have demonstrated that the group size in online learning significantly affects the quality of interaction between internal members (Nagel & Kotzé, 2010). Herner et al. (2002) believe that an online group size of no more than six people ensures that all members have the best possible experience of participation. Jahng et al. (2010) suggest that a group of 2–5 members can perform better as a team. Furthermore, AbuSeileek (2012) findings accurately show that groups of five members perform significantly better in terms of internal interactions than groups of 2–7 members, but also point out that some members within the group are entirely reliant on the work of others; some members are too dominant, leaving other members with little opportunity to contribute. Tomei (2006) argues that a membership size of around 12 is the ideal way to manage an online classroom efficiently. Smith and Dirx (2007) determined that four members per group were an appropriate number to avoid too many group messages arising quickly. Gedera (2014) research points out that too many people learning online can reduce the number of times students have to talk and that delays in the network cause interruptions when students answer questions, forcing them to repeat themselves later. Most studies tend to limit the number of students per group to 2–7, however, these are lessons learned from conducting online group instruction in other disciplines. Each discipline has its own pedagogical characteristics and there is a general lack of research in the field on the applicability of group sizes to design disciplines.

### The impact of engagement

Engagement refers to the number and quality of behaviours in which students raise ideas and questions to their peers or teachers in the classroom (Fassinger, 1995). Mason (2013) concluded that engagement could be used to assess student performance, and to this end, he defined three types of participants in online education. The first is active participants, who eagerly answer all questions from the instructor and actively interact with other peers; the second are lurkers, who read and complete the tasks assigned by the instructor but are usually hesitant to interact with others; and the third is complete non-participants, who enter the online classroom and speak by the course's minimum requirements. Rocca (2008) study mentions that teacher behaviour has a significant impact on increasing students' interest in participation. For example, when the teacher's language is commanding and aggressive, students show low interest in participation. Taylor (2002) came to similar conclusions by investigating student engagement in online classes and therefore advocates that schools should use student engagement in online classes as a rating scale and develop detailed scoring parameters to encourage students to engage with their peers and, where possible, identify the reasons for gaps between engagement levels.

### The impact of the teaching platform interface

The “ Universal Design for Learning” (UDL) framework, developed by the Center for Applied Special Technology in 1990, was initially designed to use technology to improve the presentation of teaching resources and student assessment patterns in the digital age

(Murphy, 2021). Given the lack of a physical contact environment for online education, Houston (2018) proposed using the (UDL) framework to design and develop online teaching courses. The research results demonstrated that this could significantly increase students' interest in engaging with the learning community. Trostle Brand et al. (2012) also believe that this framework allows for greater flexibility in sharing teaching resources and strategies, which in turn can effectively address the changing challenges of the online learning environment. Lee et al. (2012) found that a unified interaction logic and layout of the platform helped students learn quickly and reduce unfamiliarity, facilitating communication within the group. Following a controlled experiment in which postgraduate students at a university were divided into two online learning groups, Vonderwell and Zachariah (2005) suggest that the interactive interface of the teaching platform should be multithreaded to allow teachers to manage multiple online groups at the same time. However, that care should be taken to limit the number of groups to avoid information overload. Based on qualitative research, Gedera (2014) observed that students were challenged by early exposure to online education platforms because they were unfamiliar with the features on the platform. For example, they were unsure how to set the status of their camera usage. There is a lag in accessing instructional platforms for design students who are fresh to university and for some older teachers who do not have much experience using digital facilities (Adedoyin & Soykan, 2020).

## Conclusion

Previous research has focused on the “interactive” aspect of group learning. “Interaction” involves groups that include educators and learners and software-based digital instructional resources. Many studies have demonstrated that group size, member participation, and the interface architecture of the teaching platform all impact the quality of online teaching and learning. In general, group learning has proved to be an essential component of instructional activities in design disciplines, and there is a rich case study of past research into online group learning, but most of it has explored some general influences relevant to all disciplines.

## Methodology

### Introduction

As discussed in the initial literature review, a typical method utilised in most online group learning studies is to encourage stakeholders to participate and thereby collect their perspectives (Guest et al., 2018; Kim, 2013; Lee et al., 2012). This research strategy has been well practised and has demonstrated feasibility (Davies et al., 2012). Therefore, this study continues implementing the tenet of user-centred research by inviting people associated with group learning in design disciplines to participate in the research methodology. A two-track research methodology consisted of participatory design workshops (PD) and one-to-one interviews. The participatory design was implemented early in the research, allowing a diverse group of participants to participate in the research as equals (Sanders et al., 2018), who would be encouraged to post insights on online group learning awareness and interface layout to help the researcher understand the problem from the user's perspective. The interviews focused on collecting self-reports from participants (Denscombe, 2014),



using content analysis to gain more insight into the specific feelings of students and teachers about various aspects of online group learning. By practicing both research methods, participants' expectations and perceptions of online group instruction can be explored from different perspectives, and the data obtained from both methods can be cross-validated to increase the reliability of the findings. The research follows the University of Leeds ethical guidelines, anonymizing participants to safeguard their privacy.

## Context

In response to the risks presented by the Covid-19 pandemic, all teaching and supervision activities for the MA Design programme offered by the University of Leeds ran, in academic year 2020–21, were taken online. This study was conducted throughout three terms by one of its students in response to a brief presented by their supervisor, covering modules on research methods, research and design, and dissertation. Within that context, the study could provide timely insights into the programme's required adaptation and transformation, as well as on the uses of industry tools (such as the Microsoft Teams platform), which were quickly adopted by educational institutions for remote learning and teaching. In many ways, this study's methodology reflects that institution's research-led approach to teaching, as well as characteristics typical of design learning itself, such as teamwork, and problem-based learning (Frascara, 2017).

## Participant profile

The two research methods involved a total of 34 participants (11 educators, 23 learners), whose common characteristics were that they were all currently engaged in studies related to the field of design and had at least six months of online group learning or teaching experience. The research backgrounds of the selected participants encompass a wide range of fields, including interaction, graphic, colour, service, typography, art, and fashion design, to increase the reliability of the findings and make the sample more adaptable. The age of the learners tended to be in the same range (20–30 years old), and the age of the educators ranged from 30 to 64 years old. Detailed background information on the participants is presented separately in the following sections.

## Participants in participatory design workshops

The number of participants was 12, consisting of 6 teachers (3 Males, 3 Females) and 6 students (2 Males, 4 Females). They were divided into 3 independent workshop sessions (50 min each) based on their educational status, and this classification pattern enabled a later test of whether participants from diverse backgrounds had varied understandings of the research topic. Table 1 presents information on participants using the sessions as categorical themes.

## Participants in one-to-one interviews

For one-on-one interviews, a total of 22 participants were selected as samples, including 17 students (3 Male and 14 Female) and 5 teachers (3 Male and 2 Female). Students are all recruited from the MA Design programme in the University of Leeds (except for students undertaking the same brief as part of their studies). That programme is

**Table 1** Information on participants in participatory design workshops

Workshop code	Gender	Age (years)	Identity	Research background
Workshop [1]	Male	21	Learner	Graphic design
	Male	23	Learner	Service design
	Female	24	Learner	Interactive design
	Female	24	Learner	Interactive design
Workshop [2]	Male	55	Educator	Graphic design
	Male	52	Educator	Service design
	Female	38	Educator	Colour design
	Female	34	Educator	Graphic design
Workshop [3]	Male	64	Educator	Fashion design
	Female	36	Educator	Interactive design
	Female	24	Learner	Art and design
	Female	23	Learner	Interactive design

characterized by developing and supporting students to undertake research in different design areas; therefore, participants show differentiation in specific research directions (Leeds, 2021). Table 2 presents specific background information on students and teachers.

**Table 2** Participant information for one-on-one interviews

Attribute		Number	Percentage
<i>Learner</i>			
Age(years)	18–25	13	76
	26–30	4	24
Gender	Male	3	18
	Female	14	82
Research Background	Graphic design	5	29
	Interactive design	4	23
	Art design	3	18
	Packaging design	2	12
	Service design	1	6
	Social design	1	6
	Type design	1	6
<i>Educator</i>			
Age(years)	30–40	2	40
	41–50	2	40
	51–60	1	20
Gender	Male	3	60
	Female	2	40
Research background	Interactive design	2	40
	Graphic design	2	40
	Service design	1	20

## Procedure of methods

### Participatory design workshop

The PD workshops consist of 1 open-ended activity and 1 heuristic creative activity (Table 3), both of which rely on online collaborative software. The open-ended word activity is designed to ask participants to use words for summarizing their views on their past involvement in online group teaching and aims to develop critical thinking. This individual activity ensures that participants' thoughts are not influenced (Robertson & Simonsen, 2013). Collaborative processes (convergent thinking) are more likely to produce more inspiration than individual creativity (Björgvinsson et al., 2012). Participants in the creative activity worked together to create a wireframe for the ideal interface layout of the online teaching platform, getting insight into their internal preferences for the online group teaching platform's interaction mode and interface layout. The emphasis on individual activities in the early phase and the implementation of cooperation in the later phase allows members to express their opinions and exchange ideas to gain new ideas (Sanders et al., 2010).

### One-to-one interviews

The interviews were semi-structured to ensure that all of the prepared questions were answered while allowing the respondents more latitude in explaining their points of view to share ideas (Denscombe, 2014). The interview consisted of 3 parts in total. The first part was a collection of background information, the second consisted of 7 questions that had to be answered, and the last part was open-ended and optional. The moderator asks hard questions, the interviewees give their independent views on the questions, and the one-to-one format ensures that they can articulate more clearly. Furthermore, because the interviewees include both students and teachers, who play diverse roles in online group learning, specific changes to the exact interview questions have been made, although they all share the same characteristics. They will approach the questions from the following angles:

- Number, frequency and content of group learning
- Feelings discussed within the student group
- Purpose of implementing group learning

**Table 3** Introduction to participatory design workshop activities

Activity name	Introduction	Time	Delivery
Open-ended word activity	Each participant contributed 16 words regarding online group teaching (the most important, relevant, significant, and challenging), subsequently whittled down to four words per person	15 min	Padlet
Creative activity	Based on their experiences with group teaching, participants draw up an interface diagram (wireframe) of the online teaching platform and then work together to revise and optimize the design	35 min	Miro

- The way teachers and students communicate with each other
- Compare the feeling of the offline group
- Managing the group experience
- Assessing individual and group outcomes

## Results and analysis

### Introduction

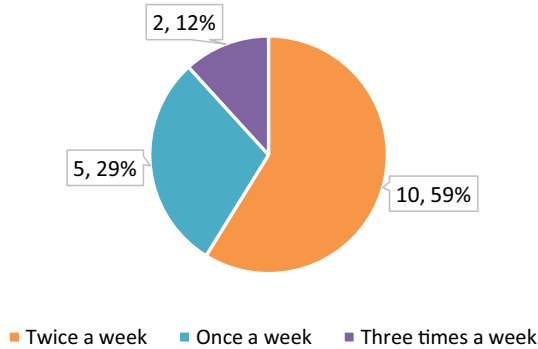
The study obtained feedback from stakeholders on several areas of online group learning through a participatory design and one-on-one interviews. A three-stage procedure of data transcription, content analysis, and visual presentation was carried out using Nvivo software (QSR, 2021). All interviews were transcribed as text and sorted into thematic categories (Braun & Clarke, 2006). They were then analyzed using content analysis methods and backed up by quotes from participant responses. For retention and characterization, the photos are then screenshotted or scanned. In order to better cite and label the interview data, participants were given different IDs according to their status in online education (Teacher = T, Student = S). The research analysis of the data aims to explore and answer the following questions: “What is the value of online group learning for the design discipline? What factors influence the quality of online group learning in design disciplines? What are the potential advantages of online group learning? What are the specific challenges for the design discipline in implementing online group learning?” Since many participants’ perspectives on specific issues were similar, the article merged and summarized them with an apparent propensity to be similar to reduce the quantity of text or graphics used in the study and make it more understandable. Almost all participants noted that network quality stability affects the online group learning experience, similar to prior studies; however, this is more of a problem to be solved in the realm of communication technology and hence will not be considered a factor in this study.

### Frequency of group learning and types of tasks

The interview’s first two questions are intended to determine the percentage of small-group learning in the subject’s teaching and learning activities and the precise types of tasks covered. All teachers ( $N=5$ ) reported teaching in small groups at least once a week. After the pandemic, 59% of students ( $N=10$ ) said they experienced an average of two weekly group learning sessions. More than three group learning opportunities per week would be reported by 12% of students ( $N=2$ ). 29% of the students ( $N=5$ ) said they had a group study experience once a week (see Table 4). However, all teachers and students stated that the number of lessons per week influenced the actual frequency of implementation, so the data presented is merely an average reference figure. Overall, every participant said they had at least one group learning experience every week, indicating that group learning makes up many online delivery activities in design disciplines.

Regarding specific task types, most students reported that they had participated in at least three different learning tasks. 88% of participants ( $N=15$ ) said they most often participated in small design projects, followed by 76% of students ( $N=13$ ) who reported that some theoretical topic discussions were common. This was acknowledged by all teachers, who also stated that they assigned some tasks for brainstorming, information gathering,

**Table 4** Frequency of students' participation in group learning

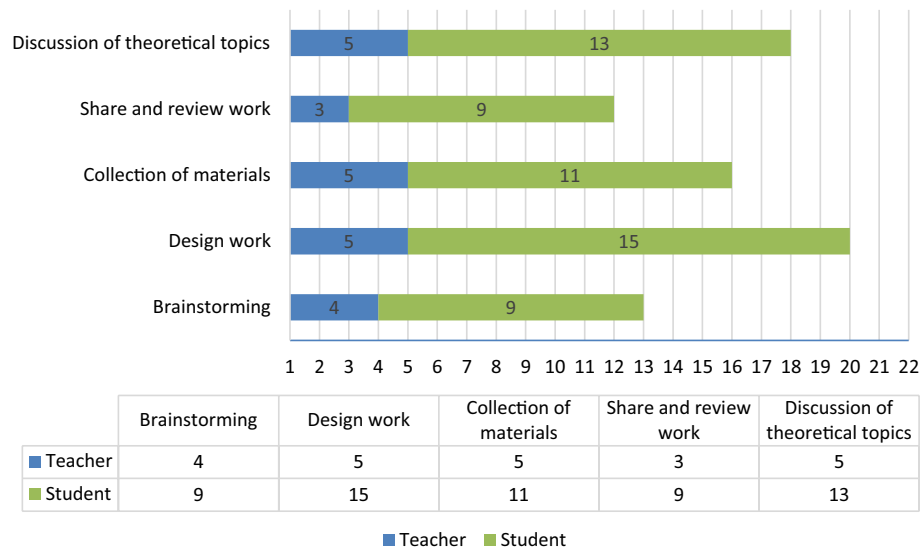


and work evaluation (Table 5). The above data demonstrates that the design discipline has a much broader range of tasks that students learn, including practical design projects and theoretical research.

### Students' and teachers' perceptions of online group learning

Understanding the metrics of online courses from the stakeholders' perspective is critical, as their perceptions can significantly impact the development of subsequent teaching strategies (Guest et al., 2018). Participants used words to interpret their perceptions of online group learning in an open-ended activity designed by PD. At this point, 12 participants (6 teachers and 6 students) contributed 192 words describing online group learning, narrowing the scope to 48 words (4 words each). The study found that most participants agreed on evaluating online learning after grouping words of similarity, the same attribute, and

**Table 5** Types of group learning tasks reported by participants



	Brainstorming	Design work	Collection of materials	Share and review work	Discussion of theoretical topics
Teacher	4	5	5	3	5
Student	9	15	11	9	13

Teacher Student



**Table 6** Reasons affecting the size of online groups in design disciplines

Reasons	Quotations
(1) Reasonable distribution of tasks	<p><i>"There are usually several tasks, and each member is responsible for one of them, and it all comes together."</i> [IDs S3, S4, S5, S12]</p> <p><i>"Ideally three to five, preferably four, to give them a greater diversity of ideas and to facilitate the internal division of labour."</i> [ID T1]</p> <p><i>"Group discussion consists of research, design and testing, and one person is responsible for each part to ensure that the learning results are suitable for most people."</i> [ID S1]</p>
(2) Avoiding awkward silent situations	<p><i>"Three people are the best match to avoid the awkwardness of two people..."</i> [IDs S7, S9]</p> <p><i>"Sometimes, when we disagree, we vote to elect a workable answer."</i> [IDs S4, S6, S8, S12, S14, S16]</p>
(3) Limitations of online collaboration software	<p><i>"Many times we need to use design software to collaborate on tasks, and,,, usually has more than four people, and the software gets laggy."</i> [ID S4]</p> <p><i>"I like to use online collaboration software with my classmates. If there are too many participants, the interface will have too many moving signs, and the picture will be confused."</i> [IDs S2, S7, S11]</p> <p><i>"While most synchronous collaboration software claims to support multiple people working simultaneously, more than five users often get stuck."</i> [IDs S1, S16]</p>
(4) Reducing the teaching load	<p><i>"..., if each group is limited to a minimal number of students, e.g. 2–3, many groups will be created, and 4 to 5 students per group is the appropriate allocation rule."</i> [ID T3]</p> <p><i>"If too many groups are included in the teaching, more time must be spent listening to the presentations one by one."</i> [ID T4]</p>

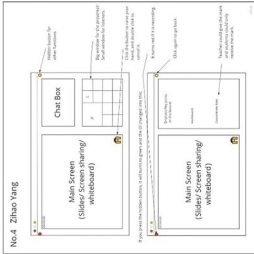
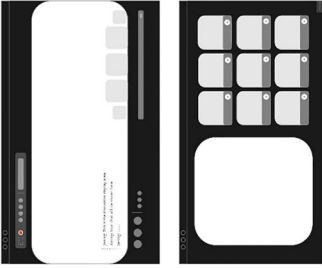
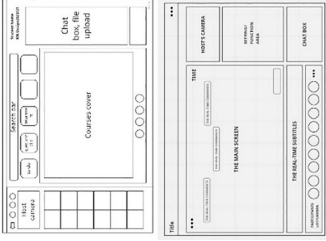
## The impact of the platform's interface and interaction logic

This section contains data from the participatory design (creative activity) and one-to-one interviews.

### Participatory design (creative activity)

In this activity, participants worked in groups to present their ideas for the online real-time teaching platform interface, which was further developed into a wireframe diagram. There is a common perception of teachers' and students' views on online instructional platforms, but they differ in their specific focus. The teachers' preference for controlling several groups via the camera shows that the platform was previously inconvenient for managing many groups simultaneously. Instead, students focused on developing the chat box design, which was seen as a convenient medium for interaction. However, keeping the main area for sharing screens or collaborative whiteboards and having a participant camera area was agreed upon by all participants (see Table 7).

**Table 7** Interface design of the instructional platform provided by the participants

Session code	Session 1 (all students)	Session 2 (all teachers)	Session 3 (2 students, 2 teachers)
Interface			
Individual features	<p><i>Main screen:</i> has the chat box and camera area</p> <p><i>Group interface:</i> the right-hand side is all captions and file transfer logs</p>	<p><i>Main interface:</i> the chat area is on the left, and the student's avatar can be switched at any time on the right</p> <p><i>Group interface:</i> All group discussions can be observed in real-time</p>	<p><i>Main interface:</i> the video area on the left, the chat area on the right and the different groups can be accessed at any time above</p> <p><i>Group interface:</i> the top holds the thumbnail box of the group interface</p>
Common features	<p>Reserve half of the area as the main area for a shared screen or drawing whiteboard area</p> <p>The chat boxes have all been retained as an important function</p> <p>The camera is considered to be a vital interaction medium</p> <p>The main interface allows the teacher to have access to both observe and view the discussions of each group at any time</p>		



These ideas were likewise echoed by many of the participants in the interviews, which will be detailed subsequently.

### One-to-one interview data

Over two-thirds of the participants agreed that the web-based group learning format made it simpler to transfer digital educational materials (e.g. ID T3; see their quotes in Table 7), which is consistent with many prior studies' findings (Cheung, 2021). Instructional resources for the design discipline include more software packages, digital files, links to web collaboration tools, etc. The chat box was seen by students as an essential medium for achieving rapid transfer of teaching resources in this process, echoing the preference of teachers and students for this feature in the PD workshop. However, the rapid transfer of instructional resources puts pressure on students to manage documents from different courses, resulting in information overload (Vonderwell & Zachariah, 2005). Because they frequently moved between digital teaching resources utilising a single device, most students said they could not fully immerse themselves in group discussions (e.g. S1, S13, S14). Information overload was exacerbated by students' lack of digital abilities, with several (IDs S4, S7, and S12) noting that they needed to learn manipulatives early in the course, resulting in reduced discussion time.

Furthermore, all teachers acknowledged the difficulties of managing many groups on the teaching platform and the absence of physical access, making multiple managing groups simultaneously tricky. Furthermore, in line with the feedback provided by teachers in the PD workshops, some of the teachers who participated in the interviews indicated that the camera was an ideal window for Interaction (Cole et al., 2021), but that students rarely turned it on (IDs T2, T3, T5). 68% of participants ( $N=15$ ) reported that offline instruction could be interactive by observing facial expressions, but online discussions with the camera turned off led to a further reduction in the medium of interaction. Providing a virtual dynamic image of the avatar seemed an excellent solution strategy (IDs S13, S15), which avoided students being directly confronted with a static "screen wall", but other participants' responses did not further explain their perceptions of this strategy. Table 8 shows the specific challenges posed by the interactive interface and operational logic and the corresponding references.

### The impact of the way teachers manage their groups

Instructors shared ways of interacting with the group and strategies for assessing learning outcomes (Table 9). Regarding posting tasks, some teachers (IDs T2, T3, T5) tended to use the chat box for text messaging rather than speaking, which was the same as the students' habit. The teachers (IDs T1, T2, T3) felt that "Regular or Irregular Spaced Communication" would allow for good student monitoring and feedback when interacting with their groups. In addition, some teachers (IDs T2, T4) assign tasks in advance to enable an accurate assessment of individual performance. Furthermore, the opportunity to analyze each student group's outcomes in the primary virtual classroom allows other students to comment on the results, allowing for more interaction and shared learning. The strategies offered by the teachers seemed to address the challenges posed by the online format for managing groups, but the responses from students reflected the 'blind spots' in this management strategy, which are explained in the following sections.

**Table 8** Challenges caused by interactive interfaces

Challenges	Quotations
(1) Managing multiple groups	<p>“When I get into a group, sometimes people turn off their cameras or do not talk, and I cannot judge their participation.” [IDs T1, S11, S12, S15]</p> <p>“I prefer Zoom for group teaching because it is easier to manage many groups simultaneously.” [ID T2]</p> <p>“Teams and DingTalk require students to enter or leave groups independently.” [IDs T4, T5]</p>
(2) Sharing instructional resources	<p>“I normally upload group tasks, including links and papers, to the main virtual classroom before the group meeting so members can examine them at any time.” [IDs T2, T3]</p> <p>“Chat boards are also a good way for me to share content with students temporarily.” [IDs T2, T4]</p> <p>“When I have a new idea in my head, I need to open up a collaboration software like a whiteboard and share it with the group, which takes much time.” [ID S12]</p>
(3) The strangeness of the operational logic	<p>“Zoom had better navigation, and I could easily divide students into groups, but it did not allow me to keep minutes for long periods.” [ID T2]</p> <p>“Many features are just icons without explanations, so I am afraid to click on a feature in case something goes wrong.” [IDs S3, S7, S9, S16]</p> <p>“The teacher published a group list in Teams, and we found the group we belonged to, but in the first few meetings, we did not pay attention to where to find the specific group and how to join...” [IDs S4, S7, S12]</p> <p>“Technology limits students’ reactions, and sometimes students cannot find places to share or turn on their cameras, resulting in sessions that take longer than when I do physical teaching.” [ID T2]</p>
(4) Interface information overload	<p>“... In order to compare the designs of several team members at the same time, I had to open different software, but some software did not support split-screen very well...” [ID S14]</p> <p>“I had to switch back and forth between many apps... The screen limits me from doing more things.” [IDs S1, S13]</p>
(5) Facial contact	<p>“Maybe for those who do not want to turn on the camera, there are some virtual scenes because I do not want to talk to the wall.” [IDs S13, S15]</p> <p>“Many people do not turn on their cameras and cannot watch facial expressions to communicate with each other.” [IDs T1, T2, T5, S1, S4, S9, S11, S12, S15]</p> <p>“If I can see the other person’s facial expression, I can tell when he or she wants to speak, thus avoiding simultaneous conflict.” [IDs S5, S6, S8, S12, S16]</p>

### The impact of conflict within student groups

88% of the students ( $N=15$ ) reported a great deal of conflict within the online group, which resulted in many times not being able to have an intra-group discussion or having to extend the time, ultimately reducing the interactive experience between members. They described specific influencing factors in five areas (Table 10). Nearly half of

**Table 9** Teachers' behavior in managing online groups

Behaviours	Quotations
(1) Posting of instructional tasks	<p>"I like to send the instruction to students via chat so they can check up on the latest news." [IDs T2, T3]</p> <p>"If I join a group and find that their discussion is inefficient, I will directly assign specific tasks; for example, A is responsible for task 1, and B is responsible for task 2." [IDs T2, T4]</p>
(2) Monitoring and responding to students	<p>"... I will go into random groups and ask them where they are at..." [ID T2]</p> <p>"I usually send them back to the big conference room to report on their achievements at a certain time." [IDs T1, T3]</p> <p>".. Regularly ask students who are not speaking if they have any problems or opinions." [ID T2]</p>
(3) Assessing individual performance	<p>"It is a little difficult because when I go into other groups, I cannot monitor the other groups, and I usually just ask them what each person is responsible for." [ID T1, T5]</p> <p>"Assign each person's responsibilities in advance, and once they submit the group work, I can easily identify each person's efforts." [ID T2]</p>
(4) Assessing the learning outcomes of the group	<p>"Some teachers like to ask questions in order of name; for example, student A is invited to give A group report this time, and student B is invited next time." [ID S1]</p> <p>"....., I would have every student in a group participate in the presentation, each introducing his or her part of the presentation." [IDs T1, T2, T4, T5]</p> <p>"Assessment sessions are usually conducted in the main virtual classroom, where students share their results on a shared screen so that other groups can watch and comment." [IDs T1, T2]</p>

the students reported conflicts in assigning specific tasks, such as members preferring relatively easy tasks, resulting in some tasks being left unattended (IDs S4, S11). This caused the pre-team to spend more time coordinating the division of labour than carrying out the work. Furthermore, there were sometimes ambiguous perceptions of the task within the student group and discrepancies in ideas between members, which required teacher intervention (e.g. IDs S6, S9). However, the online format requires more steps to establish a connection between the student group and the teacher (Chang & Kang, 2016), and students cannot raise their hands or call out in the same way as in a physical classroom (an issue later fixed by an update of the online system used). Without immediate access to the teacher, interactions may have to be suspended or delayed until the teacher enters the group to coordinate. Although instructors believe that they can achieve as much quality interaction with the group as possible through inspection, there is a time lag, and by the time the inspection reaches the group, the problem may have been solved or skipped. The difficulty in interacting with the teacher promptly causes the online group to take more time to complete the same task at the same difficulty level.

**Table 10** Types of conflict that exist within the group

Factors	Quotations
(1) Unclear group tasks	<p><i>"Sometimes, our whole group did not understand the meaning of the task."</i> [ID S9]</p> <p><i>"When there is confusion on the task within the group, we tend to discuss and solve the problem internally and try not to go to the teacher. It is very troublesome, and he may deal with the problem in another group."</i> [IDs S2, S7, S8, S11, S17]</p> <p><i>"If the problem has seriously affected the progress of the discussion, such as being unable to log in to a certain software, we will select one person to contact the teacher through Teams."</i> [IDs S1, S2, S6, S9, S11]</p> <p><i>"It would be nice if the teacher could see the group discussion and join in."</i> [ID S6]</p>
(2) The way of assigning tasks	<p><i>"Because students from different cultures are organised together, sometimes no one is willing to take the initiative to do a certain task..."</i> [IDs S4, S11]</p> <p><i>"... No one volunteered to assign tasks, leading to silence for the first few minutes."</i> [IDs S4, S8, S9, S11, S15]</p>
(3) Participation of members	<p><i>"... Some people are too pushy and want to speak up on everything, and sometimes they have to listen to their point of view to maintain group harmony."</i> [ID S5]</p> <p><i>"The lack of gestures and body movements, coupled with the distractions of the Internet, has led some people to choose not to share their opinions... or to adopt someone else's opinion."</i> [IDs S3, S11, S12, S13, S15]</p> <p><i>"I could not see their faces, sometimes they only spoke once for a long time, and there was not enough collaborative atmosphere within the team."</i> [IDs S1, S9, S15]</p>
(4) Differences in ideas	<p><i>"... Internal members sometimes give up cooperation because they have different ideas and go their way."</i> [IDs S13, S17]</p> <p><i>"We must spend more time discussing an acceptable outcome to all."</i> [ID S1]</p> <p><i>"Everyone's personality is different, and in the absence of a teacher's supervision, some people will directly choose silence to express their dissatisfaction."</i> [IDs S1, S17]</p>

## Discussion

### Three or five members is the appropriate number for online group learning

Group size's impact on online courses' quality is mainly determined by interactivity, and class size has been demonstrated to affect student involvement with the class (Kim, 2013; Nagel & Kotzé, 2010). This was also acknowledged by the participants in the early stages of the interviews. A summary analysis of the responses revealed a consensus among students and teachers on group size allocation, which was similar to the findings of some previous studies (Jahng et al., 2010) that maintaining 3 to 5 members per group is an appropriate size, which is influenced by generic factors (e.g. task format and length of instruction), but also by design or collaborative software capacity. With this number of students, the instructor is confident that the activity of ideas within the group can be ensured, and that each student can participate in the interaction on the task; on the other hand, this avoids generating too many groups and prolonging the instructional assessment. Students believe there is a single way of interaction in a group of two, and a group of three is more suitable for interactive discussion. And the maximum capacity of the design software results in the

best software interaction experience for collaborative designs, usually with no more than 5 members. In addition, establishing an odd number of panel members ensures that internal gaps in opinion can always emerge, avoiding a situation where opinions are balanced and deadlocked. Overall, a group of 3 or 5 members was considered as the most appropriate online group size for the design discipline.

### **Instructional information overload and lack of digital skills training**

The objective characteristics of online education dictate that courses must be delivered through a specific educational platform, and the interface of the software is the most direct point of contact, so identifying the quality of interaction between teachers and students and the teaching platform is crucial. However, teachers' reports did not focus on whether students had adequate software collaboration skills, which is similar to previous findings (Le et al., 2018)). Due to a lack of training in relevant digital experiences, some students can experience anxiety when accessing the teaching platform, particularly when experiencing connectivity issues that make the experience slower (Adedoyin & Soykan, 2020; Gedera, 2014). Consequently, students were slow to engage in group discussions and share content, taking more time to familiarize themselves with the functions, and the actual group discussion time was compressed. In contrast to the asynchronous training videos provided by the MOOC, providing synchronous instructor-led simulations before the start of the lesson would be more advantageous in responding to students' queries. In addition, unfamiliarity with the interface makes it more challenging for learners to interact with instructional resources (Vonderwell & Zachariah, 2005). As analysed earlier, instructional resources for design disciplines (e.g. software packages, images, websites, etc.) are more efficient and convenient to transfer in the online format. However, with a single device interface as the operating platform, students need to spend much energy switching back and forth between different educational resources, resulting in their inability to immerse themselves in the interaction with their peers—an issue that could be mitigated by optimizing the number different formats of learning resources.

### **Independent learning and free-riding behaviour within the group**

Student report assignments and discussions often break out in conflict, which affects the interaction between members. Although some instructors try to decrease conflicts by assigning specific tasks to each member in advance, this could also affect collaboration between students. In this model, learners often aim to achieve personal fulfilment at the expense of interacting with other group members (Le et al., 2018). The individual modules of the group tasks work independently, making it harder to bring the final outputs together. In the interviews, 91% of the participants (N=20) reported that group tasks in the design discipline were predominantly small design projects. As tasks in design projects are sequential, low-quality outcomes in one session (task) can reduce the performance of the whole group and outcomes are sometimes assessed as a whole, with more able students being forced to take on more responsibility to ensure overall performance (Chang & Kang, 2016). Although educators attempted to reinforce teamwork by entering groups from time to time to check in and help students build a collaborative environment (Coll et al., 2013), the online format prevented educators from monitoring multiple groups simultaneously, limiting awareness to groups with immediate need for help. In addition, student responses referred to difficulties in communicating with colleagues, with some students disengaging

from the group discussion by turning off the camera and some speaking rarely or agreeing with each other outright; or responding only briefly when the teacher entered the group. These low or no contributors rarely participate in the interaction within the group but enjoy the results of the group discussions, resulting in “Free-Riding” behavior in learning (Le et al., 2018). Some previous studies and student responses also mention that implementing anonymous peer review strategies can reduce the frequency of this behavior (Chin & Overton, 2005), and that students will have to take responsibility for improving the evaluation of themselves by other members.

### **The mismatch between teachers’ actions and students’ expectations**

Previous research has identified the difficulties that the online format causes teachers in managing groups, focusing on accurately assessing the achievements of individual members and achieving high-quality interaction with groups of students. Teachers providing immediate and efficient feedback to group members have been shown to help them maintain the effectiveness of their interactions (Coll et al., 2013). Although instructors indicated that they were confident in assessing student group performance and described specific assessment strategies, limitations of the online system previously described might cause a discrepancy between the monitoring of group learning and student expectations, and that “High delayed interaction” existed between the teacher and the group discussion process. This is reflected in the difficulty of obtaining quick guidance from the educator when problems are encountered during group discussions (Järvelä & Hadwin, 2013), which can lead to discussions being stopped or misdirected. The online format isolates physical space (Malmberg et al., 2015) and is constrained by online platforms that force teachers to immerse themselves in interactions with one group for a fixed period, lacking the senses to manage the status of multiple groups simultaneously (Chang & Kang, 2016). The delay in the teacher’s perception of the group’s needs results in a mismatch between “student needs” and “teacher support” in time. In some respects, subsequent updates to the online collaboration platform have mitigated those issues, by providing easier ways to organize and navigate groups.

### **Conclusion**

This research exposes the multiple factors influencing online group learning in design disciplines and the complexities. A user-centered “Dual-track” research approach (participatory design and one-to-one interviews) was implemented to investigate the factors that influence the quality of online group learning interactions from the perspective of design students and teachers by reviewing past research on online group learning and taking into account the characteristics of teaching and learning activities in design disciplines.

Through its analysis, the study first confirmed that group learning is an invaluable teaching method in the design discipline. It also argues that “interaction” is at the heart of online group learning in design disciplines and that several factors condition the experience of teachers and students in this process. Some factors are prevalent, and others are not mentioned in previous studies of online group learning in other disciplines. Following a qualitative analysis of participants’ responses categorized by theme, the study defined four main factors influencing the quality of group learning interactions: group size, interaction interface, management approach and intra-group conflict. After further cross-analysis of the

various categories of influencing elements, the study found precise interactions between them, and some specific issues and phenomena were further identified.

Firstly, group size has also been shown to affect the quality of group learning, with three or five participants considered to be the appropriate number for designing individual group learning in the subject, mainly due to the specific type of multi-session tasks and unique software. The group can create a good learning dynamic and avoid confrontation at this size. Secondly, the study identified difficulties in the management of group learning sessions. The limitations of the platform hamper communication between teachers and students in the online format. Assigning students to tasks in advance ensures greater clarity on subsequent assessment tasks, but this can lead to groups splitting from groups to individuals. Students focus on their tasks among themselves, making an already fragile online group even looser. A difficulty in group work management might cause blind spots in the perception of collaborative work, and a lack of correspondence in the timing of the “interaction”, which has led to independent learning and “free-riding” within the group by some students. The online format makes sharing some of the teaching resources easier. However, the large amount of design subject content that is converted into online documents makes it challenging for learners to manage teaching resources and further contributes to information overload. In addition, we have identified the need for students to be trained in digital interaction skills, to support them in managing online learning content and participating in group discussions simultaneously.

Overall, a reasonable group size ensures a well-defined division of labor patterns and frequency of interaction in online discussions. Educators who manage to increase the frequency of interaction can stimulate collaborative behavior within the group and avoid negative learning by some students. Increased training of students in digital competencies will enable them to become more confident and proficient in handling online instructional resources, and more energy can be diverted to interaction with other members of the community. This study can serve as an empirical basis for further exploring online group learning in different design disciplines and can provide a reference strategy for future design faculty and students in terms of online group learning. Indeed, many of the issues discussed by this study have been, later, addressed by adoption of new tools and update of existing ones, the adoption and dissemination of practices in online teaching, as well as clearer guidance for students on collaborative teamwork.

**Acknowledgements** Authors would like to thank all students and educators who took part in the study; Dr. Vien Cheung and Dr. Nina Hansopaheluwakan-Edward, as well as MA Design students Ms. Fei Shu, Ms. Di Hu, and Ms. Kai Liu, who assisted in inviting the participants and collecting data.

**Funding** This research was carried out while the authors were studying at the University of Leeds, and the article is based primarily on the dissertation for a master’s degree. The research was not supported by any form of funding from any organisation or individual.

## Declarations

**Conflict of interest** The authors have no conflicts of interest to declare.

**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not

permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

## References

- AbuSeileek, A. F. (2012). The effect of computer-assisted cooperative learning methods and group size on the EFL learners' achievement in communication skills. *Computers & Education*, *58*(1), 231–239. <https://doi.org/10.1016/j.compedu.2011.07.011>
- Adedoyin, O. B., & Soykan, E. (2020). Covid-19 pandemic and online learning: The challenges and opportunities. *Interactive Learning Environments*, *31*(3), 1–13. <https://doi.org/10.1080/10494820.2020.1813180>
- Adobe. (2021). *Collaborate on Creative Cloud Libraries*. Retrieved 27 Sep 2021 from <https://helpx.adobe.com/creative-cloud/help/collaboration.html>
- Al Fadda, H. (2019). The relationship between self-regulations and online learning in an ESL blended learning context. *English Language Teaching*, *12*(6), 87–93. <https://doi.org/10.5539/elt.v12n6p87>
- Alhusban, A. A., Alhusban, S. A., & Alhusban, M. A. (2022). How the COVID 19 pandemic would change the future of architectural design. *Journal of Engineering, Design and Technology*, *20*(1), 339–357. <https://doi.org/10.1108/JEDT-03-2021-0148>
- Ali, A., & Smith, D. (2015). Comparing social isolation effects on students attrition in online versus face-to-face courses in computer literacy. *Issues in Informing Science and Information Technology*, *12*(1), 11–20. <https://doi.org/10.28945/2174>
- Asadpour, A. (2021). Student challenges in online architectural design courses in Iran during the COVID-19 pandemic. *E-Learning and Digital Media*, *18*(6), 511–529. <https://doi.org/10.1177/20427530211022923>
- Bargh, J. A., & Schul, Y. (1980). On the cognitive benefits of teaching. *Journal of Educational Psychology*, *72*(5), 593–604. <https://doi.org/10.1037/0022-0663.72.5.593>
- Barnes, D. R. (1992). *From communication to curriculum*. Heinemann.
- Björgvinsson, E., Björgvinsson, E., Ehn, P., & Hillgren, P.-A. (2012). Design things and design thinking: contemporary participatory design challenges. *Design Issues*, *28*(3), 101–116.
- Blitz, C. L. (2013). *Can online learning communities achieve the goals of traditional professional learning communities? What the literature says*. <http://ies.ed.gov/ncee/edlabs>
- Boling, E., & Smith, K. M. (2014). Critical issues in studio pedagogy: Beyond the mystique and down to business. In B. Hokanson & A. Gibbons (Eds.), *Design in educational technology: Design thinking, design process, and the design studio* (pp. 37–56). Springer. [https://doi.org/10.1007/978-3-319-00927-8\\_3](https://doi.org/10.1007/978-3-319-00927-8_3)
- Bolliger, D. U., & Martin, F. (2018). Instructor and student perceptions of online student engagement strategies. *Distance Education*, *39*(4), 568–583. <https://doi.org/10.1080/01587919.2018.1520041>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Catt, S. E., Miller, D. S., & Schallenkamp, K. (2007). You are the key: Communicate for learning effectiveness. *Education*, *127*(3), 369–377.
- Ceylan, S., Şahin, P., Seçmen, S., Somer, M. E., & Süher, K. H. (2021). An evaluation of online architectural design studios during COVID-19 outbreak. *Archnet-IJAR: International Journal of Architectural Research*, *15*(1), 203–218. <https://doi.org/10.1108/ARCH-10-2020-0230>
- Chang, B., & Kang, H. (2016). Challenges facing group work online. *Distance Education*, *37*(1), 73–88. <https://doi.org/10.1080/01587919.2016.1154781>
- Cheung, A. (2021). Synchronous online teaching, a blessing or a curse? Insights from EFL primary students' interaction during online English lessons. *System*, *100*, 102566. <https://doi.org/10.1016/j.system.2021.102566>
- Chin, P., & Overton, T. (2005). *Assessing group work: advice and examples*. The Higher Education Academy, Physical Sciences Centre, Primer, vol. 6.
- Cole, A. W., Lennon, L., & Weber, N. L. (2021). Student perceptions of online active learning practices and online learning climate predict online course engagement. *Interactive Learning Environments*, *29*(5), 866–880. <https://doi.org/10.1080/10494820.2019.1619593>
- Coll, C., Rochera, M. J., de Gispert, I., & Barriga, F. D. (2013). Distribution of feedback among teacher and students in online collaborative learning in small groups. *Digital Education Review*, *23*, 27–46. <https://doi.org/10.1344/DER.2013.23.27-45>



- Cross, N. (1982). Designerly ways of knowing. *Design Studies*, 3(4), 221–227. [https://doi.org/10.1016/0142-694X\(82\)90040-0](https://doi.org/10.1016/0142-694X(82)90040-0)
- Cross, N. (1993). Science and design methodology: A review. *Research in Engineering Design*, 5(2), 63–69. <https://doi.org/10.1007/BF02032575>
- Crowther, P. (2013). Understanding the signature pedagogy of the design studio and the opportunities for its technological enhancement. *Journal of Learning Design*, 6(3), 18–28. <https://doi.org/10.5204/jld.v6i3.155>
- 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>
- Dannels, D. P., & Martin, K. N. (2008). Critiquing critiques: A genre analysis of feedback across novice to expert design studios. *Journal of Business and Technical Communication*, 22(2), 135–159. <https://doi.org/10.1177/1050651907311923>
- Davies, R., Yeung, E., Mori, B., & Nixon, S. A. (2012). Virtually present: The perceived impact of remote facilitation on small group learning. *Medical Teacher*, 34(10), e676–e683. <https://doi.org/10.3109/0142159X.2012.687490>
- Davis, B. G. (2009). *Tools for teaching*. Wiley.
- Denscombe, M. (2014). *The good research guide: For small-scale social research projects* (5th ed.). Open University Press. <http://ebookcentral.proquest.com/lib/leeds/detail.action?docID=1910221>
- Durling, D., Cross, N., & Johnson, J. (1996). *Personality and learning preferences of students in design and design-related disciplines IDATER 1996 Conference*.
- Dwyer, K. K., Bingham, S. G., Carlson, R. E., Prisbell, M., Cruz, A. M., & Fus, D. A. (2004). Communication and connectedness in the classroom: Development of the connected classroom climate inventory. *Communication Research Reports*, 21(3), 264–272. <https://doi.org/10.1080/08824090409359988>
- Eren, E. T., Yılmaz, S., & Düzenli, T. (2023). The attitudes of landscape architecture students towards distance and face-to-face education methods and the effects of the two education methods on academic achievement in the project course. *International Journal of Technology and Design Education*, 33(3), 1221–1241. <https://doi.org/10.1007/s10798-022-09771-0>
- Farrell, R., & Hooker, C. (2013). Design, science and wicked problems. *Design Studies*, 34(6), 681–705. <https://doi.org/10.1016/j.destud.2013.05.001>
- Fassinger, P. A. (1995). Understanding classroom interaction. *The Journal of Higher Education*, 66(1), 82–96. <https://doi.org/10.1080/00221546.1995.11774758>
- Faust, J. L., & Paulson, D. R. (1998). Active learning in the college classroom. *Journal on Excellence in College Teaching*, 9(2), 3–24.
- Fewella, L. N. (2023). Impact of COVID-19 on distance learning practical design courses. *International Journal of Technology and Design Education*. <https://doi.org/10.1007/s10798-023-09806-0>
- Frascara, J. (2017). Design, and design education: How can they get together? *Art, Design & Communication in Higher Education*, 16(1), 125–131. [https://doi.org/10.1386/adch.16.1.125\\_1](https://doi.org/10.1386/adch.16.1.125_1)
- Frisby, B. N., & Martin, M. M. (2010). Instructor-student and student-student rapport in the classroom. *Communication Education*, 59(2), 146–164. <https://doi.org/10.1080/03634520903564362>
- Gedera, D. (2014). Students' experiences of learning in a virtual classroom: An activity theory perspective. *International Journal of Education and Development Using ICT*, 10(4), 93–101.
- Gerry, S., Koschmann, T., & Suthers, D. (2006). Computer-supported collaborative learning: An historical perspective. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 409–426). Cambridge University Press.
- Glen, R., Suci, C., & Baughn, C. (2014). The need for design thinking in business schools. *Academy of Management Learning & Education*, 13(4), 653–667. <https://doi.org/10.5465/amle.2012.0308>
- Green, L. N. (2005). A study of the design studio in relation to the teaching of industrial & product design. In *Doctoral Thesis, University of Canberra*.
- Guest, R., Rohde, N., Selvanathan, S., & Soesmanto, T. (2018). Student satisfaction and online teaching. *Assessment & Evaluation in Higher Education*, 43(7), 1084–1093. <https://doi.org/10.1080/02602938.2018.1433815>
- Han, J., Park, D., Hua, M., & Childs, P. R. N. (2022). Is group work beneficial for producing creative designs in STEM design education? *International Journal of Technology and Design Education*, 32(5), 2801–2826. <https://doi.org/10.1007/s10798-021-09709-y>
- Hernández-Nanclares, N., García-Muñoz, A. S., & Rienties, B. (2017). Making the most of “external” group members in blended and online environments. *Interactive Learning Environments*, 25(4), 467–481. <https://doi.org/10.1080/10494820.2016.1140656>
- Herner, L., Higgins, K., Pierce, T., & Miller, S. (2002). Study groups for active learning opportunities in preservice education. *Professional Educator*, 25(2), 29–40.

- Hillman, D. C. A., Willis, D. J., & Gunawardena, C. N. (1994). Learner-interface interaction in distance education: An extension of contemporary models and strategies for practitioners. *American Journal of Distance Education*, 8(2), 30–42. <https://doi.org/10.1080/08923649409526853>
- Holmberg, B. (2020). Guided didactic conversation in distance education. *Distance education: International perspectives* (pp. 114–122). Routledge. <https://doi.org/10.4324/9781003033950-10>
- Houston, L. (2018). Efficient strategies for integrating universal design for learning in the online classroom. *The Journal of Educators Online*. <https://doi.org/10.9743/JEO.2018.15.3.4>
- Jahng, N., Nielsen, W. S., & Chan, E. K. H. (2010). Collaborative learning in an online course: A comparison of communication patterns in small and whole group activities. *Journal of Distance Education*, 24(2), 39–58.
- Järvelä, S., & Hadwin, A. F. (2013). New frontiers: Regulating learning in CSCL. *Educational Psychologist*, 48(1), 25–39. <https://doi.org/10.1080/00461520.2012.748006>
- Jones, D., Lotz, N., & Holden, G. (2021). A longitudinal study of virtual design studio (VDS) use in STEM distance design education. *International Journal of Technology and Design Education*, 31(4), 839–865. <https://doi.org/10.1007/s10798-020-09576-z>
- Jung, I., Choi, S., Lim, C., & Leem, J. (2002). Effects of different types of interaction on learning achievement, satisfaction and participation in web-based instruction. *Innovations in Education and Teaching International*, 39(2), 153–162. <https://doi.org/10.1080/14703290252934603>
- Kaufmann, R., Sellnow, D. D., & Frisby, B. N. (2016). The development and validation of the online learning climate scale (OLCS). *Communication Education*, 65(3), 307–321. <https://doi.org/10.1080/03634523.2015.1101778>
- Kim, J. (2013). Influence of group size on students' participation in online discussion forums. *Computers & Education*, 62, 123–129. <https://doi.org/10.1016/j.compedu.2012.10.025>
- Kolko, J. (2011). Chapter One-Thinking About People. In J. Kolko (Ed.), *Thoughts on interaction design* (2nd ed., pp. 20–39). Morgan Kaufmann. <https://doi.org/10.1016/B978-0-12-380930-8.50001-2>
- Kurucay, M., & Inan, F. A. (2017). Examining the effects of learner-learner interactions on satisfaction and learning in an online undergraduate course. *Computers & Education*, 115, 20–37. <https://doi.org/10.1016/j.compedu.2017.06.010>
- Le, H., Janssen, J., & Wubbels, T. (2018). Collaborative learning practices: Teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education*, 48(1), 103–122. <https://doi.org/10.1080/0305764X.2016.1259389>
- Lee, C.-Y., Dickerson, J., & Winslow, J. (2012). An Analysis of organizational approaches to online course structures. *Online Journal of Distance Learning Administration*, 15(1), n1.
- Leeds, U. O. (2021). *Design MA*. Retrieved 10 Oct 2021 from <https://courses.leeds.ac.uk/a672/design-ma>
- Liu, T., & Huang, Y. (2020). Going online? China's response in higher education system to the pandemic. *Beijing International Review of Education*, 2(3), 460–465. <https://doi.org/10.1163/25902539-00203011>
- MacMahon, S., Leggett, J., & Carroll, A. (2020). Promoting individual and group regulation through social connection: Strategies for remote learning. *Information and Learning Science*, 121(5/6), 353–363. <https://doi.org/10.1108/ILS-04-2020-0101>
- Malmberg, J., Järvelä, S., Järvenoja, H., & Panadero, E. (2015). Promoting socially shared regulation of learning in CSCL: Progress of socially shared regulation among high- and low-performing groups. *Computers in Human Behavior*, 52, 562–572. <https://doi.org/10.1016/j.chb.2015.03.082>
- Mason, R. (2013). *Using communications media in open and flexible learning*. Routledge.
- Mayende, G., Muyinda, P. B., Isabwe, G. M. N., Walimbwa, M., & Siminyu, S. N. (2014). *Facebook Mediated Interaction and Learning in Distance Learning at Makerere University*. International Association for Development of the Information Society.
- Mayende, G., Prinz, A., Isabwe, G. M., & Muyinda, P. B. (2017). Learning groups in MOOCs: Lessons for online learning in higher education. *International Journal of Engineering Pedagogy*, 7(2), 109–124. <https://doi.org/10.3991/ijep.v7i2.6925>
- McMahon, K., Ruggeri, A., Kämmer, J. E., & Katsikopoulos, K. V. (2016). Beyond idea generation: The power of groups in developing ideas. *Creativity Research Journal*, 28(3), 247–257. <https://doi.org/10.1080/10400419.2016.1195637>
- Miller, N., & Hertz-Lazarovits, R. (1992). *Interaction in cooperative groups: The theoretical anatomy of group learning*. Cambridge University Press.
- Moller, L. (1998). Designing communities of learners for asynchronous distance education. *Educational Technology Research and Development*, 46(4), 115–122.
- Moore, M. (1989). Three types of interaction. *American Journal of Distance Education*, 3(2), 1–7. <https://doi.org/10.1080/08923648909526659>

- Moser, K. M., Wei, T., & Brenner, D. (2021). Remote teaching during COVID-19: Implications from a national survey of language educators. *System*, 97, 102431. <https://doi.org/10.1016/j.system.2020.102431>
- Murphy, M. P. (2021). Belief without evidence? A policy research note on Universal Design for Learning. *Policy Futures in Education*, 19(1), 7–12. <https://doi.org/10.1177/1478210320940206>
- Nagel, L., & Kotzé, T. G. (2010). Supersizing e-learning: What a CoI survey reveals about teaching presence in a large online class. *The Internet and Higher Education*, 13(1), 45–51. <https://doi.org/10.1016/j.iheduc.2009.12.001>
- Oak, A., & Lloyd, P. (2016). ‘Throw one out that’s problematic’: Performing authority and affiliation in design education. *CoDesign*, 12(1–2), 55–72. <https://doi.org/10.1080/15710882.2015.1110179>
- O’Donnell, A., Alexander, P., & Winne, P. (2006). *Handbook of educational psychology*. Mahwah: Lawrence Erlbaum Associates. <https://doi.org/10.4324/9780203874790>
- Qin, X., & Li, Y. (2020). Application of online-offline mixed teaching mode in landscape design course. *Design*, 33(15), 110–112.
- QSR. (2021). *Nvivo*. Retrieved 01 Oct 2021 from <https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home/>
- Qu, L., Chen, Y., Rooij, R., & de Jong, P. (2020). Cultivating the next generation designers: Group work in urban and regional design education. *International Journal of Technology and Design Education*, 30(5), 899–918. <https://doi.org/10.1007/s10798-019-09540-6>
- Robertson, T., & Simonsen, J. (2013). *Routledge International handbook of participatory design*. Routledge. <https://doi.org/10.4324/9780203108543>
- Rocca, K. A. (2008). Participation in the college classroom: The impact of instructor immediacy and verbal aggression. *The Journal of Classroom Interaction*, 43(2), 22–33.
- Romig, J. E., & Alves, K. D. (2021). Implementing individual opportunities to respond in online teaching environments. *Journal of Special Education Technology*, 36(2), 84–89. <https://doi.org/10.1177/01626434211004120>
- Rosa, C., & Ferreira, J. (2023). The distant studio: A survey of design students’ experience with distance educational formats. *International Journal of Technology and Design Education*. <https://doi.org/10.1007/s10798-022-09804-8>
- Ruiz, J. G., Mintzer, M. J., & Leipzig, R. M. (2006). The impact of e-learning in medical education. *Academic Medicine*, 81(3), 207–212. <https://doi.org/10.1097/00001888-200603000-00002>
- Saldanha, K., Currin-McCulloch, J., Muskat, B., Simon, S. R., Bergart, A. M., Mesbur, E. S., Guy, D., Chilwalo, N. B., Seck, M. M., Tully, G., & Lind, K. (2021). Turning boxes into supportive circles: Enhancing online group work teaching during the COVID-19 pandemic. *Social Work with Groups*, 44(4), 310–327. <https://doi.org/10.1080/01609513.2021.1910110>
- Sanders, E. B.-N., Brandt, E., & Binder, T. (2010). A framework for organizing the tools and techniques of participatory design. In *Proceedings of the 11th Biennial Participatory Design Conference*, Sydney. <https://doi.org/10.1145/1900441.1900476>
- Sanders, E. B.-N., Singh, S., & Braun, E. (2018). Co-designing with communities. In *Community Engagement Conference*, Columbus. <http://hdl.handle.net/1811/84231>
- Sellahewa, H. (2011). Using an online student response system in small group teaching: A pilot study. *Innovation in Teaching and Learning in Information and Computer Sciences*, 10(3), 38–43. <https://doi.org/10.11120/ital.2011.10030038>
- Shea, P., Hayes, S., Vickers, J., Gozza-Cohen, M., Uzuner, S., Mehta, R., Valchova, A., & Rangan, P. (2010). A re-examination of the community of inquiry framework: Social network and content analysis. *The Internet and Higher Education*, 13(1), 10–21. <https://doi.org/10.1016/j.iheduc.2009.11.002>
- Smith, R. O., & Dirks, J. M. (2007). Using consensus groups in online learning. *New Directions for Adult and Continuing Education*, 2007(113), 25–35. <https://doi.org/10.1002/ace.244>
- Stepanyan, K., Mather, R., & Dalrymple, R. (2014). Culture, role and group work: A social network analysis perspective on an online collaborative course. *British Journal of Educational Technology*, 45(4), 676–693. <https://doi.org/10.1111/bjet.12076>
- Taylor, J. C. (2002). Teaching and learning online: The workers, the lurkers and the shirkers. In *Proceedings of the 2nd Conference on Research in Distance and Adult Learning in Asia*, Beijing, China.
- Thompson, L., & Ku, H.-Y. (2006). A case study of online collaborative learning. *Quarterly Review of Distance Education*, 7(4), 361–375.
- Tomei, L. A. (2006). The impact of online teaching on faculty load: Computing the ideal class size for online courses. *Journal of Technology and Teacher Education*, 14(3), 531–541.
- Trostle Brand, S., Favazza, A. E., & Dalton, E. M. (2012). Universal design for learning: A blueprint for success for all learners. *Kappa Delta Pi Record*, 48(3), 134–139. <https://doi.org/10.1080/00228958.2012.707506>

- Vonderwell, S., & Zachariah, S. (2005). Factors that influence participation in online learning. *Journal of Research on Technology in Education*, 38(2), 213–230. <https://doi.org/10.1080/15391523.2005.10782457>
- Vrasidas, C. (2000). Constructivism versus objectivism: Implications for interaction, course design, and evaluation in distance education. *International Journal of Educational Telecommunications*, 6(4), 339–362.
- Webb, N. M. (2009). The teacher's role in promoting collaborative dialogue in the classroom. *British Journal of Educational Psychology*, 79(1), 1–28. <https://doi.org/10.1348/000709908X380772>
- Yilmaz, S., & Daly, S. R. (2016). Feedback in concept development: Comparing design disciplines. *Design Studies*, 45, 137–158. <https://doi.org/10.1016/j.destud.2015.12.008>
- Yorgancıoğlu, D., & Tunali, S. (2020). Changing pedagogic identities of tutors and students in the design studio: Case study of desk and peer critiques. *Art, Design and Communication in Higher Education*, 19, 19–32. [https://doi.org/10.1386/ADCH\\_00011\\_1](https://doi.org/10.1386/ADCH_00011_1)
- Zhang, S., Wen, Y., & Liu, Q. (2019). Exploring student teachers' social knowledge construction behaviors and collective agency in an online collaborative learning environment. *Interactive Learning Environments*, 30(3), 539–551. <https://doi.org/10.1080/10494820.2019.1674880>
- Zimmerman, T. D. (2012). Exploring learner to content interaction as a success factor in online courses. *The International Review of Research in Open and Distributed Learning*, 13(4), 52–165. <https://doi.org/10.19173/irrodl.v13i4.1302>

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.