



Collaborative learning in online breakout rooms: Effects of learner attributes on purposeful interpersonal interaction and perceived learning

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Abstract

Purpose – Breakout rooms are commonly used by lecturers as a means to achieve collaborative learning in online lessons. Although breakout rooms can be effective at encouraging student engagement, interaction, and learning, many students dislike being forced to interact with peers, and for some students it can lead to feelings of anxiety and stress. Successful collaborative learning depends upon having the ‘right’ individuals working together, so the purpose of this research is to identify specific learner attributes that are associated with purposeful interpersonal interaction in breakout rooms.

Design/methodology/approach – An online survey was used to obtain data from 664 higher education students in the United States, which were analyzed using partial least squares structural equation modeling (PLS-SEM).

Findings – Students’ technology readiness, social identification, and intercultural communication competence are each significantly related to the achievement of purposeful interpersonal interaction, which is strongly related to students’ perceived learning.

Originality/value – The breakout room represents a unique and specific context for collaborative learning, where there may be minimal lecturer supervision, and where students may choose to disengage by turning off their cameras and microphones, or simply listen without participating (known as lurking). The existing literature has given little attention to how lecturers allocate students to online breakout rooms.

Practical implications – The findings of this research emphasize the importance of lecturers considering learner attributes when forming breakout room groups.

Keywords Online learning, Collaborative learning, Breakout rooms, Teaching/learning strategies, Group formation

Paper type Research paper

Introduction

The COVID-19 pandemic that started in early 2020 forced universities globally to make more use of online learning. Institution managers determined that face-to-face classes be suspended, and lecturers were instructed to consider how best to deliver online lessons to ensure that students’ learning continued with minimal disruption. As many countries transition into a post-pandemic era, the flexibility and opportunities provided by online technologies are likely to remain part of students’ learning experiences in higher education. Some students struggle with online teaching and learning because they do not have reliable internet access (Bento, 2022). Other students may not be mentally technology ready, or they may lack confidence or the necessary interpersonal and communication skills to effectively engage with peers and lecturers in online settings (Tang *et al.*, 2021). [Chaw and Tang \(2022\) found that learner characteristics may affect individuals’ preferences for particular types](#)

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3 | of learning environment. This research assesses the extent to which specific learner attributes may
4 influence individuals' attitudes and readiness for online collaborative learning. Effective
5 collaborative learning requires high quality, organic, and valid communication exchanges between
6 students, which directly relate to the achievement of established learning outcomes or to the building
7 of social relationships. Such exchanges may be regarded as purposeful interpersonal interaction.
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9 Lecturers need to structure and deliver lessons to achieve purposeful interpersonal interaction
10 among students (Nikou and Maslov, 2022). During the switch to 100% online teaching, many
11 lecturers were advised by managers, peers, and professional development trainers to use breakout
12 rooms as a means to achieving purposeful interpersonal interaction among students (McGrath and
13 Wolstencroft, 2021). A breakout room is a virtual space that is separate from the main online
14 classroom, in which only the students allocated to the room may hear and participate in discussion,
15 as well as read and write text chat messages to each other (Chandler, 2016). The main objective of a
16 breakout room is to promote collaborative learning, whereby students develop their knowledge and
17 skills through interaction with their peers (Lyons *et al.*, 2021).
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21 Collaborative learning is widely used in both physical and online classrooms. In online settings,
22 the lecturer decides how many students should be in each breakout room, and whether or not to select
23 specific students for each room. Collaborative learning may deliver both individual and group-level
24 benefits (Curşeu and Pluut, 2013). It may encourage student motivation, involvement, and
25 engagement, and it may contribute to achieving deeper understanding of program content and
26 concepts; enhanced overall learning; communication and interpersonal skills development; and higher
27 satisfaction with lesson delivery (Chen and Kuo, 2019; Lyons *et al.*, 2021). Quieter and less confident
28 students are often more willing to participate in breakout room discussions, as these may be perceived
29 as less threatening or intimidating than speaking to the whole class (Chandler, 2016).
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33 Although breakout rooms can be effective at encouraging student engagement, interaction, and
34 learning, they may allow some students to lurk, where they become free-riders, who listen and
35 observe, but not participate (Bozkurt *et al.*, 2020). Collaborative learning generally takes more time
36 than lecturer-led delivery, and it may be less effective when students lack the necessary knowledge
37 and skills to be self-reliant, or when the group has underachievers, disruptive members, or individuals
38 who refuse to interact or engage with others (Smith *et al.*, 2011). Many students dislike being forced
39 to interact with peers, and for some students it can lead to feelings of anxiety and stress (McGrath
40 and Wolstencroft, 2021). Indeed, many students turn off their cameras and microphones while in
41 breakout rooms, which may lead to awkward silences and no purposeful interpersonal interaction that
42 delivers collaborative learning.
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46 Successful collaborative learning in online breakout rooms depends upon having the 'right'
47 individuals working together, who interact with one another in a productive and supportive manner.
48 However, there is little consensus in the literature about how lecturers should create breakout room
49 groups (Chen and Kuo, 2019). Lecturers may allow the students to form their own groups, which are
50 then usually based on friendships, or the desire to work with high ability individuals who will
51 contribute most to achieving the set tasks and learning goals (Marder *et al.*, 2021). Alternatively,
52 lecturers may save time and effort by allowing the online learning platform to randomly assign
53 individuals to groups. Finally, lecturers may determine that it is best to take responsibility for group
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formation themselves. When this option is selected, a key decision is whether to create groups comprised of homogeneous or heterogeneous individuals. Regardless of this decision, the lecturer needs to consider relevant learner attributes to make his/her final allocations. Sometimes, lecturers may be able to allocate students based on existing or previous groups, perhaps stemming from earlier courses or projects. Lecturer behaviors are critical in the online classroom as these behaviors may motivate or demotivate students, and adopting a person-centered approach is more likely to result in students being engaged (Gupta, 2022).

The existing literature on student group formation has not specifically considered group formation for online breakout rooms, which represent a unique learning environment that requires students to interact with one another, usually with minimal lecturer supervision. The need to consider learner attributes for breakout room groups provides the rationale for this research, and key learner attributes that may be associated with purposeful interpersonal interaction are examined.

The study has two research questions:

RQ1 What learner attributes are associated with purposeful interpersonal interaction in online breakout rooms?

RQ2 Is purposeful interpersonal interaction associated with students' perceived learning?

Through answering these questions, we fill a literature gap that connects the group formation process with the use of online breakout rooms, and provide much needed information about the types of student who are more likely to willingly engage in purposeful student-student interaction. The findings may be useful to lecturers who want to form online breakout room groups that will maximize effective student interaction and learning.

The remainder of this paper is organized as follows. First, we present a concise literature review that discusses the study's theoretical frame and the relationship between purposeful interpersonal interaction and group membership. Then, the student attributes that may be associated with such interaction are discussed, and the associated hypotheses are specified. Following this, we discuss the relationship between purposeful interpersonal interaction and perceived learning, and specify our final hypothesis. After explaining our method, we present the results. We finish the paper with a discussion and conclusion that summarizes and analyzes the key findings, and which explains the study's contributions.

Literature review and research hypotheses

Theoretical frame

Deep and meaningful learning is possible when high quality student-student interaction occurs (Mehall, 2021). Anderson's (2003) interaction equivalency theory suggests that if student-student interaction is of a high quality, then student-lecturer and student-content interactions may be offered at minimal levels, or even not at all, without negatively affecting students' learning. Online delivery increases the physical distance between the student and lecturer, which may have negative effects on interaction and learning, but Moore's (1983) theory of transactional distance claims that well-designed activities that engage students and effective two-way communication between students and lecturers may decrease the psychological distance between them. Thus, the tasks and activities that

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3 students are asked to perform in breakout rooms may influence the perceived psychological distance
4 between students and lecturers, and individuals' perceived learning and satisfaction with the online
5 learning experience.

6 According to cognitive load theory, due to their limited working memory, learners have limited
7 cognitive processing capacity to apply acquired knowledge and skills to new situations (Kirschner *et al.*,
8 2018). If simultaneous speaking and writing (e.g., text chat) are undertaken in the breakout room,
9 higher cognitive load and ambiguity may result, leading to lower quality learning. Levels of
10 interaction, learning, attainment, and satisfaction are influenced by the individual's personality type,
11 e.g., as explained by the Big Five Personality Trait Model (Costa and McCrae, 1992). Although the
12 traits of conscientiousness, openness, agreeableness, and neuroticism may each contribute to
13 explaining an individual's suitability or non-suitability for collaborative learning in a breakout room,
14 extroverts are typically talkative and energetic, and they enjoy activities undertaken in the company
15 of others, making them ideal breakout room participants (Eftekhar *et al.*, 2014). Each of the theories
16 mentioned in this section has implications for the quality of purposeful interpersonal interaction that
17 may occur in online breakout rooms.
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24 **Purposeful interpersonal interaction and group membership**

25 The main aim of breakout rooms is to achieve purposeful interpersonal interaction between students
26 that will result in effective learning. Purposeful interpersonal interaction may be defined as, 'any high
27 quality, organic, and valid communication exchange between two or more participants of the learning
28 process that directly relates to the achievement of established learning outcomes or to the building of
29 social relationships' (Mehall, 2020, 185). Student-to-student interaction may be critical to students'
30 learning because, as Anderson's (2003) interaction equivalency theory argues, if student-student
31 interaction is of a high quality, then other types of interaction may be offered at minimal levels, or
32 even not at all, without negatively affecting students' learning. With many universities having very
33 large classes, it is often difficult to achieve high quality student-lecturer interaction.
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37 An effective breakout group typically requires individual members to assume different roles,
38 taking responsibility for things such as organization, providing information, creating an action plan,
39 solving problems, motivating others, supporting others, and monitoring/evaluating performance
40 (Yeh, 2010). Role assignment and group size may each influence individual participation, peer
41 interaction, and learning achievement (Luo *et al.*, 2023). A number of studies have concluded that
42 purposeful interaction and collaborative learning is more effective with heterogeneous groups, where
43 there is a mix of students in terms of gender, ethnic background, ability, and personality traits (e.g.,
44 Jong *et al.*, 2006; Scheurell, 2010; Wang *et al.*, 2007). In contrast, Chen and Kuo (2019) recommend
45 creating groups where students are heterogeneous in terms of knowledge and learning roles, but
46 homogenous in terms of social interactions among group members. Regardless of whether a student
47 group is heterogeneous or homogenous, individuals who possess an outgoing personality, who can
48 relate well to others, and who have good communication skills may be more willing to interact with
49 their peers in breakout rooms. However, for breakout rooms to be effective, individuals need to have
50 a positive attitude toward online and collaborative learning, and possess technology readiness.
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57 **Technology readiness**

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3 Previous research has indicated that online learning is most effective when the students are ready for
4 online learning, and in particular when they possess technology readiness (Tang *et al.*, 2021).
5 Technological readiness is an essential aspect of student readiness for online learning. For example,
6 Walia *et al.* (2019) specified student readiness for online learning as comprising access to technology,
7 technology skills, teaching presence, cognitive presence, social presence, lifestyle factors, and
8 individual skills and study habits. According to Parasuraman (2000), technology readiness refers to
9 an individual's propensity to embrace and use new technologies for accomplishing specific goals.
10 Furthermore, students' perceived usefulness of online learning may influence their willingness to
11 engage with it (Singh and Tewari, 2021). Warden *et al.* (2020) found that although smart devices are
12 ubiquitous, some students are anxious about online learning, and that students who are less
13 comfortable with technology possess lower self-efficacy in social interactions with their peers. Chau
14 *et al.* (2020), Ferrer *et al.* (2022), and Flores *et al.* (2022) conclude that student technology readiness
15 is critical to achieving effective online learning, as technology readiness promotes a favorable attitude
16 toward online learning, which impacts upon an individual's motivation and engagement.
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23 *H1.* Students' technology readiness is positively related to purposeful interpersonal interaction in
24 breakout rooms.
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26 **Extroversion**

27 An extrovert enjoys high levels of activity and arousal, and has a tendency toward social behavior,
28 assertiveness, impulsiveness, and the display of positive emotions (Busato *et al.*, 2000). Extroverts
29 find social situations more pleasant than introverts, and therefore are likely to enjoy breakout room
30 interaction with peers more than the introverts. Previous research has found that extroverts are more
31 willing to speak in public and that they experience lower levels of anxiety (Fraj-Andrés *et al.*, 2018).
32 In a study of online learning during the COVID-19 pandemic, Hong *et al.* (2021) concluded that
33 extroversion can positively predict internet and academic self-efficacy. Although Sanudin *et al.*
34 (2022) found that introverts view online learning positively, these individuals may lurk and not
35 participate in discussion or interaction with peers. Indeed, extrovert students are more likely to engage
36 in purposeful interpersonal interaction in breakout rooms. A study by Weiser *et al.* (2018) found that
37 extroverts spoke more in almost all types of teaching-learning interactions, while Barnett *et al.* (2015)
38 found that extroverts perform better in groups and on tasks requiring significant interaction with
39 others. Extroverts are more likely to be leaders, and leaders are more likely to engage in purposeful
40 interpersonal interaction, which leads to higher academic performance (Dunbar *et al.*, 2018).
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48 *H2.* Students' extroversion is positively related to purposeful interpersonal interaction in breakout
49 rooms.
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51 **Social identification**

52 Effective learning in breakout rooms requires social interaction between students. When students are
53 allowed to form the breakout groups, they typically choose classmates that are similar to themselves
54 and with whom they have prior acquaintance (Chen and Kuo, 2019). Hilton and Phillips (2010) found
55 that homogenous student-selected groups communicate better and are more enthusiastic about
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working together. However, if the lecturer forms heterogeneous groups with dissimilar students, purposeful interpersonal interaction may be lower. The concept of social identification explains that individuals view themselves as belonging to in or out-groups, which results in an ‘us’ and ‘them’ mentality. Social identification exists when an individual exhibits common characteristics or behaviors with other members of the in-group. Dean and Jolly (2012) argue that it is a student’s sense of identity that determines their level of commitment and willingness to engage with a given learning opportunity. Social identification increases social rapport, which may decrease psychological distance and increase purposeful interpersonal interaction (Woolcott, 1996). Furthermore, Wilkins *et al.* (2016) found that students’ social identification is significantly related to students’ commitment and achievement.

H3. Students’ social identification is positively related to purposeful interpersonal interaction in breakout rooms.

Intercultural communication competence

Today’s higher education classrooms typically have students with diverse social, cultural, ethnic, and religious backgrounds. To operate effectively in culturally diverse settings, students need to possess intercultural competence, i.e., the ability to communicate effectively and appropriately in intercultural situations (de Hei *et al.*, 2020). Specifically, intercultural communication competence may be regarded as an individual’s ability to achieve their communication goal while effectively and appropriately utilizing communication behaviors to negotiate between the different identities present within the culturally diverse classroom (Portalla and Chen, 2010). Chen and Starosta (1996) conceptualize intercultural communication competence as comprising of intercultural awareness, sensitivity, and effectiveness. Individuals who demonstrate understanding and respect for another’s culture and communicate with them using appropriate language and style – e.g., appropriate speed and clarity of speech – are likely to achieve higher quality purposeful interaction (Portalla and Chen, 2010).

H4. Students’ intercultural communication competence is positively related to purposeful interpersonal interaction in breakout rooms.

Perceived learning

Educators expect that breakout rooms generate purposeful interpersonal interaction, and that the purposeful interpersonal interaction results in enhanced student learning. In education research, learning is often measured by students’ self-reported perceived learning. Perceived learning refers to students’ retrospective evaluation, which results in a set of beliefs and feelings that learning has occurred (Barzilai and Blau, 2014). A number of studies have found a positive relationship between purposeful interpersonal interaction and students’ perceived learning (e.g., Blasco-Arcas *et al.*, 2013; Hernández-Sellés *et al.*, 2019; Ku *et al.*, 2013; Mehall, 2020, 2021). Specifically, with regard to breakout rooms, Tonsmann (2014) found that students may develop and apply their understanding of concepts that have been taught by the lecturer in the main room, and he concluded that breakout rooms are a valuable technique to achieve student understanding and assimilation of concepts.

H5. Purposeful interpersonal interaction is positively related to students' perceived learning.

Figure 1 presents the proposed conceptual model and the associated hypotheses.

Insert Figure 1 here

Method

Sample and data collection

The study population is full-time higher education students who study at institutions based in the United States and who have participated in online lessons in the last 12 months. Data were collected using an online survey questionnaire, which was available through CloudResearch and Prolific. Students are readily available on such platforms. Participant quality control measures were employed (see Litman *et al.*, 2017). Nothing was observed in the participants' answers to suggest that providing compensation for participation generated unreliable or unbelievable responses. A total of 664 usable responses were obtained. Of these respondents, 57.1% classified themselves as male and 42.2% as female. About a quarter of our respondents studied a business/management-related subject; the remainder studied a diverse range of subjects including computer science/information technology, engineering, liberal arts, psychology, and the natural sciences. Average online learning experience in the sample was 1.58 years, and 58% of the students typically participate in at least one breakout room every week; 38% have at least one per month; and remaining 4% participate in less than one per month.

Measures

All of the latent constructs in the model were measured using pre-existing validated scales adopted from the literature. All these scales had previously demonstrated satisfactory internal reliability, with Cronbach's alpha scores ranging from .74 to .90 in the original studies. Technology readiness was measured using Tang *et al.*'s (2021) seven item scale reflecting students' ability to acquire and use technologies in life. A six-item extroversion scale was adopted from Francis *et al.* (1992). Wilkins *et al.*'s (2016) five item scale was used to measure students' perceived social identification. The intercultural communication competence scale was adopted from Portalla and Chen (2010), which measures the interaction relaxation and message skills dimensions. An eight item scale adapted from Roblyer and Wiencke (2004) was used to measure purposeful interpersonal interaction. Finally, perceived learning was measured using a four item scale provided by Barzilai and Blau (2014). All latent constructs in this study were measured using a 7-point Likert scale, where 1 = strongly disagree and 7 = strongly agree. The survey questionnaire was subjected to pretesting with 20 students, and no issues of concern were identified. Appendix 1 specifies all of the items used to measure each construct in the model.

Data analysis

SPSS version 28 was used to clean the data and assess the demographics. Further analyses were conducted using partial least squares structural equation modeling (PLS-SEM) and the SmartPLS version 4.0.7.8 software, which enabled testing of the hypothesized relationships, and assessment of the predictive power (Sarstedt and Cheah, 2019). A major advantage of using the Smart PLS software is that in addition to providing causal explanation, it also has predictive abilities (Hair *et al.*, 2020), allowing researchers to test the explanatory and predictive power of their models (Shmueli *et al.*, 2019). Although our hypotheses are grounded in causal explanations, we expect our model to have high predictive accuracy and yield meaningful implications for practitioners.

Results

Preliminary data analysis

As the study employed a cross-sectional design, it is important to test if there is any common method bias in the data set. The variance inflation factor (VIF) scores are lower than 3.3, indicating that common method bias is unlikely to be a problem with our data (Kock, 2015). As recommended by Hair *et al.* (2020), we applied confirmatory composite analysis to test the measurement model. As presented in Table 1, all measures for internal consistency – Cronbach's alpha, rho_A and composite reliability (CR) – are above the cut criteria of 0.7, thus indicating the reliability of our measurement scales (Hair *et al.* 2019). Also, the scales demonstrated adequate convergent validity, as the average variance extracted (AVE) is higher than .50 for all the constructs. Discriminant validity was assessed using the heterotrait-monotrait (HTMT) ratio of correlations.

Insert Table 1 here

Table 2 presents the results of the test establishing discriminant validity, as all the HTMT values are lower than the conservative threshold value of 0.85 (Henseler *et al.*, 2015). Before testing the structural model, it was first established that no multicollinearity exists between the independent variables in our model. The VIF values range from 1.00 to 1.96, indicating that there is no collinearity between predictors. The relationships between different constructs was then assessed using the bootstrapping procedure with 5,000 subsamples (Hair *et al.*, 2019).

Insert Table 2 here

Hypothesis testing

Figure 2 presents an overview of the structural model results. All the hypothesized paths are significant except the path from extroversion to purposeful interaction.

Insert Figure 2 here

The R^2 for purposeful interaction is 61%, ($p < .01$), and for perceived learning it is 70% ($p < .01$) (Table 3). All f^2 values are significant except for the relationship between extroversion and purposeful interaction. The effect size for the proposed relationships in H1 and H3 are small, as the values of f^2 are in a range between .11 to .14, while H4 has a medium sized effect and H5 has a large effect size (Cohen, 2003). The blindfolding procedure was used to test the predictive relevance of the structural model. The Q^2 value for purposeful interaction is .37, and for perceived learning it is .44. This establishes that our model has strong predictive relevance, as the test values are non-zero (Chin *et al.*, 2020). These results allow us to assume and test the predictive relevance of the model using PLS predict. If all indicators in the PLS-SEM analysis have lower RMSE (or MAE) values compared to the naïve LM benchmark, the model has high predictive power (Shmueli *et al.*, 2019). Our results indicate that RMSE has lower values for the PLS model as compared to the naïve LM benchmark, and thus our model has high predictive power (Table 4).

Insert Table 3 here

Insert Table 4 here

Discussion

The purpose of this research is to identify specific learner attributes that are associated with purposeful interpersonal interaction in breakout rooms. Through answering our research questions, we fill a literature gap that connects the group formation process – i.e., the allocation of students to groups based on their individual attributes – with the use of online breakout rooms, and provide much needed information about the types of student who are more likely to willingly engage in purposeful student-student interaction.

To answer our first research question about what learner attributes are associated with purposeful interpersonal interaction in online breakout rooms, hypotheses 1, 3, and 4 are supported, meaning that students' technology readiness, social identification, and intercultural communication competence are each significantly related to the achievement of purposeful interpersonal interaction. Although our intercultural communication competence construct is concerned mainly with the individual's ability to achieve their communication goal, it also includes the behaviors needed to negotiate between the different identities present within the culturally diverse classroom. In other words, intercultural communication competence is not just about the spoken words, but also about intercultural awareness and sensitivity.

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3 The relationship between intercultural communication competence and purposeful interpersonal
4 interaction has the largest effect size among our four learner attributes. Thus, our findings support the
5 existing literature that identifies cultural differences and English language competence as key factors
6 which influence the success of students in culturally diverse settings (Straker, 2016). Universities
7 should aim to develop students' intercultural competence both in and out of the classroom. To
8 increase understanding and familiarity among students, lecturers may use breakout rooms for
9 icebreaker activities at the start of a course, when students are still getting to know one another.
10 Students could share photos and other personal media artifacts to explain their backgrounds and
11 interests in ways that allow their fellow community of learners to comment and engage in
12 conversations around common interests and experiences.
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16 Extracurricular activities, such as sports and special interest groups, may be a vehicle for
17 developing students' social identification. Such events may promote interaction, understanding, and
18 familiarity between students. To ensure that students have the technical competence to be confident
19 and effective in online lessons, universities should offer appropriate training on using the online
20 learning platform and associated learning resources. Also, if the lecturer ensures that each group has
21 at least one individual who is technically competent, these individuals may offer support to other
22 students who are less confident with using the technology.
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25 For our second research question, about the relationship between purposeful interpersonal
26 interaction and students' perceived learning (H5), it was found that the relationship is significant and
27 with a large effect size. This was to be expected, as it is a logical relationship that is well documented
28 in the literature (e.g., Blasco-Arcas *et al.*, 2013; Hernández-Sellés *et al.*, 2019; Ku *et al.*, 2013;
29 Mehall, 2020, 2021). The large effect size for the relationship between purposeful interpersonal
30 interaction and students' perceived learning emphasizes the value of group discussion and activities
31 to the individual's learning. It is important that lecturers create group tasks and activities that stimulate
32 and engage students, and which require effective team working. Lecturers may, for example, use
33 graphic organizers and apps – such as Nearpod, Pear Deck and Jamboard – to make breakout rooms
34 more engaging.
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40 **Conclusion**

41 The findings of this research emphasize the importance of lecturers considering learner attributes
42 when forming breakout room groups. To our knowledge, this is the first study to investigate the
43 relationships between a selection of learner attributes and purposeful interaction for effective
44 collaborative learning in online breakout rooms. Thus, this research fills an important literature gap.
45 We propose and validate a conceptual model for purposeful interpersonal interaction and learning in
46 online lessons, specifically in the context of breakout rooms. Thus, the theoretical contribution is
47 specific to student interaction and learning in breakout rooms, which represent a quite unique learning
48 environment, where students are expected to interact and work independently with minimal or no
49 lecturer input and where they can easily disengage by switching off their cameras and/or microphones.
50 Our model identifies three learner attributes that may be associated with purposeful interpersonal
51 interaction and effective learning.
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Lecturers need to identify individuals' prior experience and training needs before sending students into a breakout room. They must also be aware that students with different social, cultural, and ethnic backgrounds will likely have different individual attributes and different attitudes toward online collaborative learning. It is important for lecturers to monitor students' performance in breakout rooms by visiting each room as much as possible, to provide advice, support, and feedback to individuals and groups, and not to use the time that students are in breakout rooms to take a rest or catch up with other work tasks. The implications of our findings for practice and our recommendations for educators are as follows. First, lecturers need to be organized and pre-plan their online lessons. Second, lecturers need to design learning tasks that will engage students and which enable individuals to assume a specific group role for which they are suitable. Third, lecturers must recognize that students have different characteristics, attributes, and learning preferences and for any particular learning task lecturers need to determine whether a homogeneous or heterogeneous group would be more effective as well as the optimal group size to maximize individual participation and interaction. This need implies that lecturers should have access to personal information about their students, and that lecturers should make every effort to become familiar with their students so that they can identify individuals' key characteristics and attributes.

As with all research, there are some limitations to acknowledge. The study adopted a cross-sectional research design and data were collected only in one country. Future studies might use a longitudinal design to capture the students' development in technological competence, social identification, and intercultural competence, to assess the impacts on students' purposeful interaction and learning. It would be interesting to discover whether our results are replicated in different countries and with groups of learners with different social, cultural, and ethnic backgrounds. Our study considered only four antecedents of purposeful interaction, but future studies could add further predictor variables, like student self-efficacy. It would also be interesting in future to explore the impacts of the lecturer's characteristics and task design on the students' purposeful interactions in online breakout rooms.

References

- Anderson, T. (2003), "Getting the mix right again: an updated and theoretical rationale for interaction", *The International Review of Research in Open and Distributed Learning*, Vol. 4 No. 2, pp. 1-14, doi: 10.19173/irrodl.v4i2.149.
- Barnett, T., Pearson, A.W., Pearson, R. and Kellermanns, F.W. (2015), "Five-factor model personality traits as predictors of perceived and actual usage of technology", *European Journal of Information Systems*, Vol. 24 No. 4, pp. 374-390, doi:10.1057/ejis.2014.10.
- Barzilai, S. and Blau, I. (2014), "Scaffolding game-based learning: impact on learning achievements, perceived learning, and game experiences", *Computers & Education*, Vol. 70 January 2014, pp. 65-79, doi: 10.1016/j.compedu.2013.08.003.
- Bento, K. (2022), "The hysteria of a little flue: effects of COVID-19 on HEIs in Brazil", *Higher Education*, published online July 22, 2022, pp. 1-21, doi: 10.1007/s10734-022-00887-9.

- 1
2
3 Blasco-Arcas, L., Buil, I., Hernández-Ortega, B. and Sese, F.J. (2013), "Using clickers in class: the
4 role of interactivity, active collaborative learning and engagement in learning performance",
5 *Computers & Education*, Vol. 62 March 2013, pp. 102-110, doi: 10.1016/j.compedu.2012.10.019.
6
7 Bozkurt, A., Koutropoulos, A., Singh, L. and Honeychurch, S. (2020), "On lurking: multiple
8 perspectives on lurking within an educational community", *The Internet and Higher Education*,
9 Vol. 44 January 2020, 100709, doi: 10.1016/j.iheduc.2019.100709.
10
11 Busato, V.V., Prins, F.J., Elshout, J.J. and Hamaker, C. (2000), "Intellectual ability, learning style,
12 personality, achievement motivation and academic success of psychology students in higher
13 education", *Personality and Individual Differences*, Vol. 29 No. 6, pp. 1057-1068, doi:
14 10.1016/S0191-8869(99)00253-6.
15
16 Chandler, K. (2016), "Using breakout rooms in synchronous online tutorials", *Journal of Perspectives*
17 *in Applied Academic Practice*, Vol. 4 No. 3, pp. 16-23, doi: 10.14297/jpaap.v4i3.216.
18
19 Chau, K.Y., Law, K.M. and Tang, Y.M. (2021), "Impact of self-directed learning and educational
20 technology readiness on synchronous e-learning", *Journal of Organizational and End User*
21 *Computing*, Vol. 33 No. 6, pp. 1-20, doi: 10.4018/JOEUC.20211101.0a26.
22
23 Chaw, L.Y. and Tang, C.M. (2022), "Exploring the role of learner characteristics in learners' learning
24 environment preferences", *International Journal of Educational Management*, published online
25 22 November 2022, doi: 10.1108/IJEM-05-2022-0205.
26
27 Chen, C.M. and Kuo, C.H. (2019), "An optimized group formation scheme to promote collaborative
28 problem-based learning", *Computers & Education*, Vol. 133 May 2019, pp. 94-115, doi:
29 10.1016/j.compedu.2019.01.011.
30
31 Chen, G.M. and Starosta, W.J. (1996), "Intercultural communication competence: a synthesis",
32 *Annals of the International Communication Association*, Vol. 19 No. 1, pp. 353-383, doi:
33 10.1080/23808985.1996.11678935.
34
35 Chin, W., Cheah, J.H., Liu, Y., Ting, H., Lim, X.J. and Cham, T.H. (2020), "Demystifying the role
36 of causal-predictive modeling using partial least squares structural equation modeling in
37 information systems research", *Industrial Management & Data Systems*, Vol. 120 No. 12, pp.
38 2161-2209, doi: 10.1108/IMDS-10-2019-0529.
39
40 Cohen, J. (2003), "A power primer", in Kazdin, W.E. (Ed), *Methodological Issues and Strategies in*
41 *Clinical Research*, 3rd ed., American Psychological Association, Washington, DC, pp. 339-348.
42
43 Costa, P.T. and McCrae, R.R. (1992), *Neo Personality Inventory-Revised (NEO PI-R)*, Psychological
44 Assessment Resources, Odessa, FL.
45
46 Curşeu, P.L. and Pluut, H. (2013), "Student groups as learning entities: the effect of group diversity
47 and teamwork quality on groups' cognitive complexity", *Studies in Higher Education*, Vol. 38
48 No. 1, pp. 87-103, doi: 10.1080/03075079.2011.565122.
49
50 Dean, K.L. and Jolly, J.P. (2012), "Student identity, disengagement, and learning", *Academy of*
51 *Management Learning & Education*, Vol. 11 No. 2, pp. 228-243, doi: 10.5465/amle.2009.0081.
52
53 de Hei, M., Tabacaru, C., Sjoer, E., Rippe, R. and Walenkamp, J. (2020), "Developing intercultural
54 competence through collaborative learning in international higher education", *Journal of Studies*
55 *in International Education*, Vol. 24 No. 2, pp. 190-211, doi: 10.1177/1028315319826226.
56
57
58
59
60

- Dunbar, R.L., Dingel, M.J., Dame, L.F., Winchip, J. and Petzold, A.M. (2018), "Student social self-efficacy, leadership status, and academic performance in collaborative learning environments", *Studies in Higher Education*, Vol. 43 No. 9, pp. 1507-1523, doi: 10.1080/03075079.2016.1265496.
- Eftekhar, A., Fullwood, C. and Morris, N. (2014), "Capturing personality from facebook photos and photo-related activities: how much exposure do you need?", *Computers in Human Behavior*, Vol. 37 August 2014, pp. 162-170, doi: 10.1016/j.chb.2014.04.048.
- Ferrer, J., Ringer, A., Saville, K., Parris, M.A. and Kashi, K. (2022), "Students' motivation and engagement in higher education: the importance of attitude to online learning", *Higher Education*, Vol. 83 No. 2, pp. 317-338, doi: 10.1007/s10734-020-00657-5.
- Flores, M.A., Barros, A, Simão, A.M.V., Pereira, D., Flores, P., Fernandes, E., Costa, L. and Ferreira, P.C. (2022), "Portuguese higher education students' adaptation to online teaching and learning in times of the COVID-19 pandemic: personal and contextual factors", *Higher Education*, Vol. 83 No. 6, pp. 1389-1408, doi: 10.1007/s10734-021-00748-x.
- Fraj-Andrés, E., Lucia-Palacios, L. and Pérez-López, R. (2018), "How extroversion affects student attitude toward the combined use of a wiki and video recording of group presentations", *Computers & Education*, Vol. 119 April 2018, pp. 31-43, doi: 10.1016/j.compedu.2017.12.006.
- Francis, L.J., Brown, L.B. and Philipchalk, R. (1992), "The development of an abbreviated form of the revised Eysenck Personality Questionnaire (EPQR-A): its use among students in England, Canada, the USA and Australia", *Personality and Individual Differences*, Vol. 13 No. 4, pp. 443-449, doi: 10.1016/0191-8869(92)90073-X.
- Gupta, K.P. (2022), "Exploring student engagement in virtual classrooms: a person-centred approach using cluster analysis", *International Journal of Educational Management*, published online 13 December 2022, doi: 10.1108/IJEM-08-2022-0309.
- Hair, J.F., Risher, J.J., Sarstedt, M., Ringle, C.M. (2019), "When to use and how to report the results of PLS-SEM", *European Business Review*, Vol. 31 No. 1, pp. 2-24, doi: 10.1108/EBR-11-2018-0203.
- Hair Jr, J.F., Howard, M.C. and Nitzl, C. (2020), "Assessing measurement model quality in PLS-SEM using confirmatory composite analysis", *Journal of Business Research*, Vol. 109 March 2020, pp. 101-110, doi: 10.1016/j.jbusres.2019.11.069.
- Henseler, J., Ringle, C.M. and Sarstedt, M. (2015), "A new criterion for assessing discriminant validity in variance-based structural equation modeling", *Journal of the Academy of Marketing Science*, Vol. 43 No. 1, pp. 115-135, doi: 10.1007/s11747-014-0403-8.
- Hernández-Sellés, N., Muñoz-Carril, P.C. and González-Sanmamed, M. (2019), "Computer-supported collaborative learning: an analysis of the relationship between interaction, emotional support and online collaborative tools", *Computers & Education*, Vol. 138 September 2019, pp. 1-12, doi: 10.1016/j.compedu.2019.04.012.
- Hilton, S. and Phillips, F. (2010), "Instructor-assigned and student-selected groups: a view from inside", *Issues in Accounting Education*, Vol. 25 No. 1, pp. 15-33, doi: 10.2308/iace.2010.25.1.15.

- Hong, J.C., Cao, W., Liu, X., Tai, K.H. and Zhao, L. (2021) "Personality traits predict the effects of internet and academic self-efficacy on practical performance anxiety in online learning under the COVID-19 lockdown", *Journal of Research on Technology in Education*, published online September 3, 2021, pp. 1-15, doi: 10.1080/15391523.2021.1967818.
- Jong, B., Wu, Y. and Chan, T. (2006), "Dynamic grouping strategies based on a conceptual graph for cooperative learning", *IEEE Transactions on Knowledge and Data Engineering*, Vol. 18 No. 6, pp. 738-747, doi: 10.1109/TKDE.2006.93.
- Kirschner, P.A., Sweller, J., Kirschner, F. and Zambrano, R.J. (2018), "From cognitive load theory to collaborative cognitive load theory", *International Journal of Computer-Supported Collaborative Learning*, Vol. 13 No. 2, pp. 213-233, doi: 10.1007/s11412-018-9277-y.
- Kock, N. (2005), "Media richness or media naturalness? The evolution of our biological communication apparatus and its influence on our behavior toward e-communication tools", *IEEE Transactions on Professional Communication*, Vol. 48 No. 2, pp. 117-130, doi: 10.1109/TPC.2005.849649.
- Kock, N. (2015), "Common method bias in PLS-SEM: a full collinearity assessment approach", *International Journal of e-Collaboration*, Vol. 11 No. 4, pp. 1-10, doi:10.4018/ijec.2015100101.
- Ku, H.Y., Tseng, H.W. and Akarasriworn, C. (2013), "Collaboration factors, teamwork satisfaction, and student attitudes toward online collaborative learning", *Computers in Human Behavior*, Vol. 29 No. 3, pp. 922-929, doi: 10.1016/j.chb.2012.12.019.
- Kumi-Yeboah, A., Dogbey, J. and Yuan, G. (2017), "Online collaborative learning activities: the perspectives of minority graduate students", *Online Learning Journal*, Vol. 21 No. 4, pp. 5-28, doi: 10.24059/olj.v21i4.1277.
- Litman, L., Robinson, J. and Abberbock, T. (2017), "TurkPrime.com: a versatile crowdsourcing data acquisition platform for the behavioral sciences", *Behavior Research Methods*, Vol. 49 No. 2, pp. 433-442, doi: 10.3758/s13428-016-0727-z.
- Luo, H., Chen, Y., Chen, T., Koszalka, T.A. and Feng, Q. (2023), "Impact of role assignment and group size on asynchronous online discussion: an experimental study", *Computers & Education*, Vol 192 January 2023, 104658, doi: 10.1016/j.compedu.2022.104658.
- Lyons, K.M., Lobczowski, N.G., Greene, J. A., Whitley, J. and McLaughlin, J.E. (2021), "Using a design-based research approach to develop and study a web-based tool to support collaborative learning", *Computers & Education*, Vol. 161 February 2021, 104064, doi: 10.1016/j.compedu.2020.104064.
- Marder, B., Ferguson, P., Marchant, C., Brennan, M., Hedler, C., Rossi, M., Black, S. and Doig, R. (2021), "'Going agile': exploring the use of project management tools in fostering psychological safety in group work within management discipline courses", *The International Journal of Management Education*, Vol. 19 No. 3, 100519, doi: 10.1016/j.ijme.2021.100519.
- McGrath, L. and Wolstencroft, P. (2021), "I want to break free: how online breakout rooms have become a modern educational curse," Chartered Association of Business Schools, available at: <https://charteredabs.org/i-want-to-break-free-how-online-breakout-rooms-have-become-a-modern-educational-curse/>.

- 1
2
3 Mehall, S. (2020), "Purposeful interpersonal interaction in online learning: what is it and how is it
4 measured?", *Online Learning*, Vol. 24 No. 1, pp. 182-204, doi: 10.24059/olj.v24i1.2002.
- 5 Mehall, S. (2021), "Purposeful interpersonal interaction and the point of diminishing returns for
6 graduate learners", *The Internet and Higher Education*, Vol. 48 January 2021, 100774, doi:
7 10.1016/j.iheduc.2020.100774.
- 8
9 Moore, M. (1983), "On a theory of independent study", in Stewart, D., Keegan, D. and Holmberg, B.
10 (Eds), *Distance Education: International Perspectives*, Croom Helm, London, pp. 68-94.
- 11
12 Nikou, S. and Maslov, I. (2022), "Finnish university students' satisfaction with e-learning outcomes
13 during the COVID-19 pandemic", *International Journal of Educational Management*, published
14 online August 18, 2022, pp. 1-21, doi: 10.1108/IJEM-04-2022-0166.
- 15
16 Parasuraman, A. (2000), "Technology readiness index (TRI): a multiple-item scale to measure
17 readiness to embrace new technologies", *Journal of Service Research*, Vol. 2 No. 4, pp. 307-320,
18 doi: 10.1177/109467050024001.
- 19
20 Portalla, T. and Chen, G.-M. (2010), "The development and validation of the intercultural
21 effectiveness scale", *Intercultural Communication Studies*, Vol. XIX No. 3, pp. 21-37, available
22 at: https://digitalcommons.uri.edu/com_facpubs/17/.
- 23
24 Roblyer, M.D. and Wiencke, W.R. (2004), "Exploring the interaction equation: validating a rubric to
25 assess and encourage interaction in distance courses", *Journal of Asynchronous Learning
26 Networks*, Vol. 8 No. 4, pp. 24-37, available at: <http://dx.doi.org/10.24059/olj.v8i4.1808>.
- 27
28 Sarstedt, M. and Cheah, J.H. (2019), "Partial least squares structural equation modeling using
29 SmartPLS: a software review", *Journal of Marketing Analysis*, Vol. 7, pp. 196-202, available at:
30 <https://doi.org/10.1057/s41270-019-00058-3>.
- 31
32 Sanudin, S.R., Rahmat, H., Din, M.A.C. and Akeb-Urai, N. (2022), "The influence of extrovert and
33 introvert personality types on the acceptance of virtual learning during the COVID-19 pandemic:
34 a survey", *F1000Research*, Vol. 11 No. 87, pp. 1-11, available at:
35 <https://doi.org/10.12688/f1000research.73611.1>.
- 36
37 Scheuerell, S. (2010), "Virtual Warrensburg: using cooperative learning and the internet in the social
38 studies classroom", *The Social Studies*, Vol. 101 No. 5, pp. 194-199, available at:
39 <https://doi.org/10.1080/00377990903493861>.
- 40
41 Shmueli, G., Sarstedt, M., Hair, J.F., Cheah, J.H., Ting, H., Vaithilingam, S. and Ringle, C.M. (2019),
42 "Predictive model assessment in PLS-SEM: guidelines for using PLSpredict", *European Journal
43 of Marketing*, Vol. 53 No. 11, pp. 2322-2347, doi: 10.1108/EJM-02-2019-0189.
- 44
45 Singh, R. and Tewari, A. (2021), "Modeling factors affecting online learning adoption: mediating
46 role of attitude", *International Journal of Educational Management*, Vol. 35 No. 7, pp. 1405-
47 1420, doi: 10.1108/IJEM-05-2021-0198.
- 48
49 Smith, G.G., Sorensen, C., Gump, A., Heindel, A.J., Caris, M. and Martinez, C.D. (2011),
50 "Overcoming student resistance to group work: online versus face-to-face", *The Internet and
51 Higher Education*, Vol. 14 No. 2, pp. 121-128, doi: 10.1016/j.iheduc.2010.09.005.
- 52
53 Straker, J. (2016), "International student participation in higher education: changing the focus from
54 "international students" to "participation"', *Journal of Studies in International Education*, Vol.
55 20 No. 4, pp. 299-318, doi: 10.1177/1028315316628992.
- 56
57
58
59
60

- 1
2
3 Tang, Y.M., Chen, P.C., Law, K.M.Y., Wu, C.H., Lau, Y.-Y., Guan, J., He, D. and Ho, G.T.S. (2021),
4 “Comparative analysis of student’s live online learning readiness during the coronavirus
5 (COVID-19) pandemic in the higher education sector”, *Computers & Education*, Vol. 168 July
6 2021, 104211, doi: 10.1016/j.compedu.2021.104211.
7
8 Tonsmann, G. (2014), “A study of the effectiveness of Blackboard Collaborate for conducting
9 synchronous courses at multiple locations”, *InSight: A Journal of Scholarly Teaching*, Vol. 9, pp.
10 54-63, available at: <https://doi.org/10.46504/09201404to>.
11
12 Walia, P., Tulsi, P.K., and Kaur, A. (2019), “Student readiness for online learning in relation to gender
13 and stream of study”, *IEEE Learning With MOOCS*, pp. 21-25, available at:
14 <https://doi.org/10.1109/LWMOOCS47620.2019.8939651>.
15
16 Wang, D.Y., Lin, S.S. and Sun, C.T. (2007), “DIANA: a computer-supported heterogeneous grouping
17 system for teachers to conduct successful small learning groups”, *Computers in Human Behavior*,
18 Vol. 23 No. 4, pp. 1997-2010, doi: 10.1016/j.chb.2006.02.008.
19
20 Warden, C.A., Yi-Shun, W., Stanworth, J.O. and Chen, J.F. (2022), “Millennials’ technology
21 readiness and self-efficacy in online classes”, *Innovations in Education and Teaching*
22 *International*, Vol. 59 No. 2, pp. 226-236, doi: 10.1080/14703297.2020.1798269.
23
24 Weiser, O., Blau, I., and Eshet-Alkalai, Y. (2018), “How do medium naturalness, teaching-learning
25 interactions and students’ personality traits affect participation in synchronous e-learning?”, *The*
26 *Internet and Higher Education*, Vol. 37 April 2018, pp. 40-51, doi: 10.1016/j.iheduc.2018.01.001.
27
28 Wilkins, S., Butt, M.M., Kratochvil, D. and Balakrishnan, M.S. 2016. “The effects of social
29 identification and organizational identification on student commitment, achievement and
30 satisfaction in higher education”, *Studies in Higher Education*, Vol. 41 No. 12, pp. 2232-2252,
31 doi: 10.1080/03075079.2015.1034258.
32
33 Wolcott, L.L. (1996), “Distant, but not distanced: a learner-centered approach to distance education”,
34 *TechTrends*, Vol. 41 No. 5, pp. 23-27, available at: <https://doi.org/10.1007/BF02818902>.
35
36 Yeh, Y.C. (2010), “Analyzing online behaviors, roles, and learning communities via online
37 discussions”, *Journal of Educational Technology & Society*, Vol. 13 No. 1, pp. 140-151, available
38 at: <http://www.jstor.org/stable/jeductechsoci.13.1.140>.
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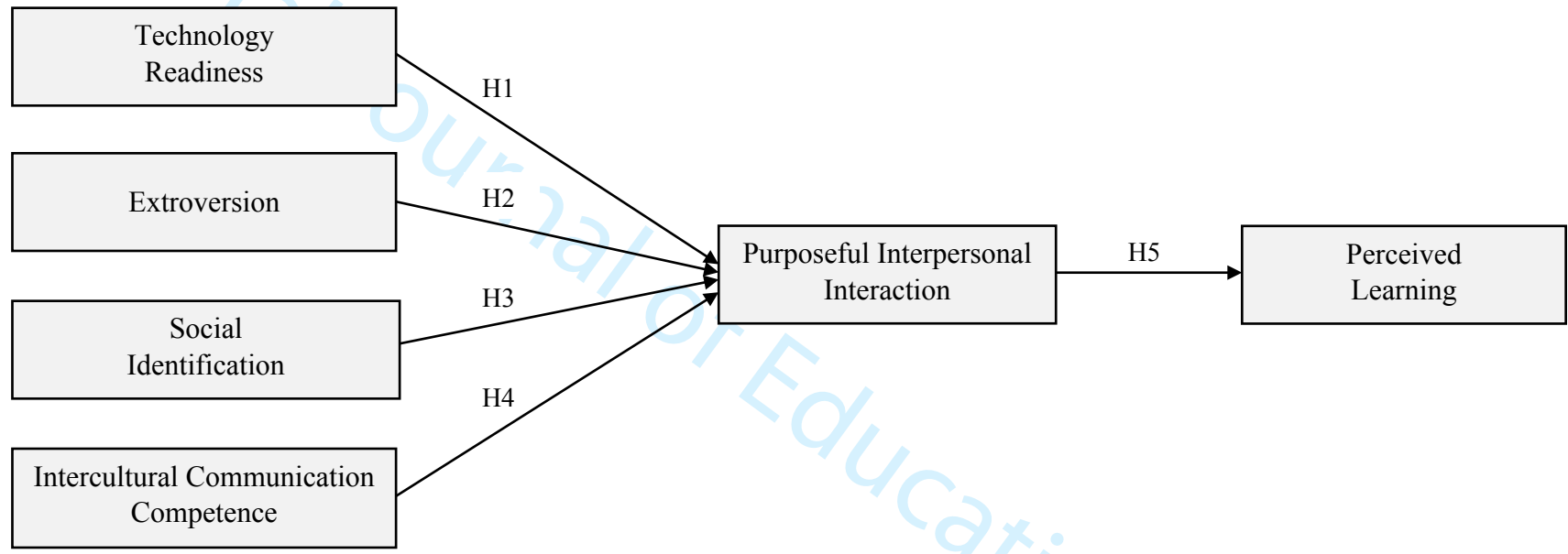


Figure 1. Proposed conceptual model

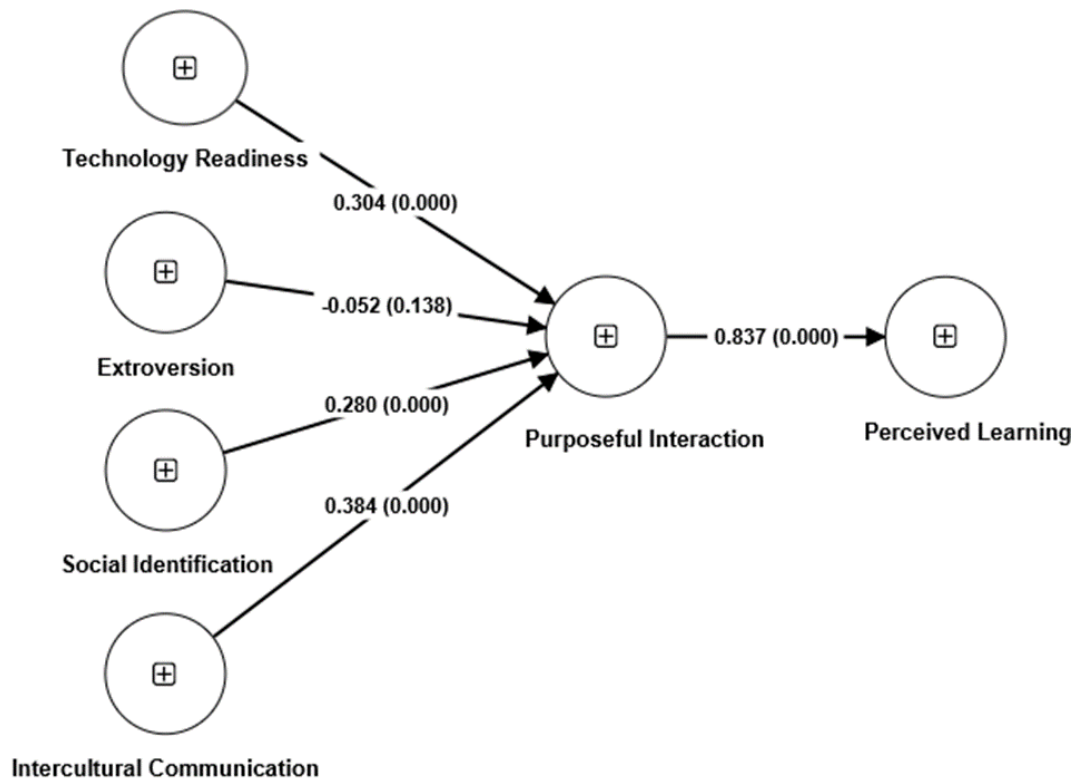


Figure 2. Structural model results

Table 1. Assessment onloading, full collinearity, reliability, and convergent validity

Construct	Item	Loading	T value	Confidence interval	Full collinearity	α	Rho_A	CR
Technology Readiness	TR1	0.772	38.25	0.73; 0.80	1.95	0.89	0.862	0.894
	TR2	0.733	34.86	0.68; 0.77				
	TR3	0.773	34.01	0.72; 0.81				
	TR4	0.678	26.11	0.62; 0.73				
	TR5	0.762	40.02	0.72; 0.80				
	TR6	0.717	27.83	0.66; 0.77				
	TR7	0.734	31.50	0.68; 0.77				
Extraversion	EX1	0.815	47.16	0.78; 0.85	1.73	0.90	0.914	0.930
	EX2	0.849	68.25	0.82; 0.87				
	EX3	0.849	69.21	0.82; 0.87				
	EX4	0.812	55.62	0.78; 0.84				
	EX5	0.758	34.59	0.71; 0.80				
	EX6	0.887	86.03	0.87; 0.91				
Social Identification	SI1	0.822	51.23	0.79; 0.85	2.11	0.86	0.885	0.916
	SI2	0.843	58.63	0.81; 0.87				
	SI3	0.846	55.26	0.81; 0.87				
	SI4	0.819	53.96	0.78; 0.84				
	SI5	0.805	44.55	0.76; 0.83				
Intercultural Communication Competence	ICC1	0.793	43.11	0.75; 0.83	2.24	0.89	0.895	0.914
	ICC2	0.789	40.78	0.75; 0.82				
	ICC3	0.781	48.84	0.75; 0.81				
	ICC4	0.770	34.82	0.72; 0.81				
	ICC5	0.810	49.56	0.77; 0.84				
	ICC6	0.665	22.49	0.60; 0.72				
	ICC7	0.676	23.67	0.62; 0.73				
	ICC8	0.747	32.38	0.70; 0.79				
Purposeful Interpersonal Interaction	PII1	0.800	48.33	0.76; 0.83	2.60	0.90	0.902	0.931
	PII2	0.786	42.61	0.75; 0.82				
	PII3	0.770	38.65	0.73; 0.80				
	PII4	0.808	51.67	0.78; 0.83				
	PII5	0.766	40.04	0.72; 0.80				
	PII6	0.811	53.18	0.78; 0.84				
	PII7	0.747	31.60	0.70; 0.79				
	PII8	0.740	36.25	0.69; 0.78				
Perceived Learning	PL1	0.868	62.14	0.84; 0.89	2.51	0.88	0.908	0.925
	PL2	0.878	76.91	0.85; 0.90				
	PL3	0.892	82.95	0.87; 0.91				
	PL4	0.874	75.52	0.85; 0.89				

Table 2. Heterotrait-Monotrait Ratio (HTMT) results

	Technology Readiness	Extroversion	Social Identification	Intercultural Communication Competence	Purposeful Interpersonal Interaction	Perceived learning
Technology Readiness	-					
Extroversion	0.59	-				
Social Identification	0.66	0.62	-			
Intercultural Communication Competence	0.62	0.62	0.67	-		
Purposeful Interpersonal Interaction	0.73	0.53	0.73	0.77	-	
Perceived learning	0.61	0.50	0.65	0.58	0.84	-

Table 3. Structural model results

Path	Coefficient	SD	T Value	Confidence Intervals		f^2	R ²	Q ²	SRMR
				2.50%	97.50%				
H1 TR to PII	0.30	0.03	8.01*	0.23	0.38	.141*			
H2 EX to PII	-0.05	0.03	1.48	-0.12	0.17	.004			
H3 SI to PII	0.28	0.04	6.39*	0.19	0.36	.107*			
H4 ICC to PII	0.38	0.04	8.42*	0.29	0.47	.208*	.61	.37	
H5 PII to PL	0.84	0.02	55.53*	0.80	0.86	2.370*	.70	.44	0.053

* $p < 0.01$

Table 4. PLS predict results

	PLS Model			LM (Linear model)			PLS-LM		
	RMSE	MAE	Q ² predict	RMSE	MAE	Q ² predict	RMSE	MAE	Q ² predict
PII1	0.963	0.716	0.361	1.004	0.746	0.306	-0.041	-0.030	0.055
PII2	0.918	0.689	0.359	0.949	0.710	0.316	-0.031	-0.021	0.043
PII3	0.961	0.738	0.348	0.992	0.761	0.305	-0.031	-0.023	0.043
PII4	0.914	0.686	0.463	0.948	0.710	0.422	-0.034	-0.024	0.041
PII5	1.023	0.765	0.324	1.063	0.794	0.270	-0.040	-0.029	0.054
PII6	1.002	0.734	0.367	1.034	0.768	0.327	-0.032	-0.034	0.040
PII7	1.003	0.750	0.366	1.010	0.769	0.356	-0.007	-0.019	0.010
PII8	1.013	0.771	0.354	1.046	0.795	0.311	-0.033	-0.024	0.043
PL1	1.236	0.921	0.279	1.222	0.903	0.296	0.014	0.018	-0.017
PL2	1.085	0.806	0.326	1.096	0.810	0.312	-0.011	-0.004	0.014
PL3	1.120	0.815	0.315	1.135	0.836	0.296	-0.015	-0.021	0.019
PL4	1.142	0.831	0.314	1.161	0.847	0.291	-0.019	-0.016	0.023

Appendix 1. Measurement scales used in this study

Construct	Items	Source	α in original study
Technology Readiness (TR)	TR1 - I prefer to use the most advanced technology available TR2 - Technology gives me more freedom of mobility TR3 - I feel confident that machines will do what I have instructed them to do TR4 - I am usually among the first to acquire new technology when it appears TR5 - I enjoy the challenge of understanding high-tech gadgets TR6 - Technology is usually reliable TR7 - Technology transmits information effectively to the intended recipient	Tang et al. (2021)	.75
Extroversion (EX)	EX1 - I am a talkative person EX2 - I am a lively person EX3 - I can usually bring some life into a dull situation EX4 - I am rarely in the background in social occasions EX5 - I am not quiet when I am with other people EX6 - Other people think that I am lively	Francis, Brown, & Philipchalk, R. (1992)	Between .74 and .84
Social Identification (SI)	SI1 - I feel a bond with the other students in my degree program SI2 - It is pleasant to be a member of the student cohort in my degree program SI3 - Being a member of the student cohort in my degree program gives me a good feeling SI4 - Fellow students are a source of friendship for me SI5 - Fellow students are a source of future networking for me	Wilkins et al. (2016)	.88
Intercultural Communication Competence (ICC)	ICC1 - I find it easy to talk with people from different cultures ICC2 - I can always initiate a conversation with people from different cultures ICC3 - I find it is easy to identify with students from different cultures ICC4 - I find it is easy to get along with students from different cultures ICC5 - I feel relaxed when interacting with students from different cultures ICC6 - I don't have grammar problems when interacting with students from different cultures ICC7 - There are rarely misunderstandings when I interact with students from different cultures ICC8 - I usually understand messages from students with a different culture to me	Portalla & Chen (2010)	.87
Purposeful Interpersonal Interaction (PII)	PII1 - Communication and relationships between students are positive in breakout rooms PII2 - Communication and relationships between students and the instructor are positive PII3 - Students work together cooperatively in groups	Roblyer & Wiencke (2004)	.85 (average)

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2		PII4 - Technologies are used effectively in online group work for two-way	
3		exchanges of information	
4		PII5 - Most students initiate and reply to messages from other students	
5		PII6 - Communication between students in online group work is detailed and	
6		beneficial to learning	
7		PII7 - Instructors provide useful feedback on students' online group work	
8		PII8 - Instructors respond to student queries promptly during online student group	
9		working	
10	Perceived	PL1 - I learn a lot in breakout rooms	Barzilai & Blau (2014) .90
11	Learning (PL)	PL2 - I gain new knowledge when working with other students in online groups	
12		PL3 - I learn new things when working with other students in online groups	
13		PL4 - I remember things I learn in breakout rooms	
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