Can avatar homophily influence flow and exploratory behaviour of online users?

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Received: 14 January 2022 / Accepted: 13 May 2022 / Published online: 28 May 2022
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Abstract
Virtual learning environments have been recognized as an area of particular importance by which educators can use to improve desirable learning behaviours. Investigating the impact of different virtual environments on learners’ behaviours has become the centre of attention of researchers, especially during COVID-19. The homophily effect of avatar-identity on individuals’ perceptions of an environment can be a key for understanding their learning behaviours. This study examined the relationship between key constructs related to avatar homophily (background and attitude) and learners’ flow and exploratory behaviour. An online survey was distributed to 157 students (93 males and 64 females with age ranging from 19 to 21 years) who took part in an online learning activity using an avatar-mediated environment (Second Life). The results showed that users’ flow experience can be influenced by the function of perceived background and attitude homophily in an avatar-mediated environment. Flow experience was found to mediate the relationship between avatar homophily and learners’ exploratory behaviour. This study offers a conceptual understanding of the relationship between homophily and individual’s flow state.

Keywords Avatar-mediated environment · Homophily · Virtual learning environment · Flow · Exploratory behaviour

1 Introduction
As virtual reality continues to proliferate throughout higher education, there is a growing interest in exploring the key antecedents of flow experience in avatar-mediated environments. This includes understanding their influence on individuals’ learning and adjustment to these environments (Alalwan et al., 2020). This can be...
reasoned to the fact that there might be some variations in the way individuals interact with others in the virtual world. Individuals’ experience has become a crucial element of learning success in computer-mediated environments, requiring educational institutions to consider elements beyond learning style and strategies (Fernandez, 2017). The use of virtual learning environments has been recognized as an area of particular importance by which educators can improve their students’ flow experience mainly through incorporating user-avatar identity or self-representation (McArthur, 2017). The literature (e.g., Li et al., 2021; Sibilla & Mancini, 2018) described the importance of user-avatar identity in a learning situation as an effective tool which has been deeply influential in recent years. User-avatar identity has the potential to offer much value for learners through entertainment and through self-customization of an avatar model to the individual parameters. Individuals’ perception of others’ avatar has been shown to have a positive benefit to the sense of presence, interaction tasks and perceptual judgments (Pan & Steed, 2019). This type of perception can be generated through homophily where users, represented by avatars, may tend to amplify and engage more with others of similar attitudes, values and symbolic status (Akchelov & Galanina, 2016; Monahan et al., 2005). Since homophily refers to the extent to which individuals are similar to others (McCroskey et al., 2006), its impact on individuals’ behaviour and perceptions has been widely explored in different contexts (Atzmueller & Lemmerich, 2018). The homophily effect of avatar-identity on individuals’ perceptions of an environment can be a key for understanding their learning behaviours.

The recent decrease in face-to-face teaching and learning, as a result of COVID-19 spread, has driven educational institutions to change the way of using digital technologies in order to improve desirable learning behaviours (Adedoyin & Soykan, 2020). However, in computer-mediated environments, it is important for educational institutions to enhance students’ flow experience as they use virtual learning tools. This is because flow experience has been always linked to individuals’ motivation, performance, and enjoyment (Ottiger et al., 2021). The flow theory, proposed by Csikszentmihalyi (2000), has been widely studied in different contexts and situations (e.g., sports, educational science, e-commerce, and gaming) (Mahfouz et al., 2020). This theory also aims at promoting individuals’ exploratory behaviour as a result of using technologies. Furthermore, avatar identity has been integrated with commercial success into numerous platforms and contexts (Procter, 2021). This study argues that such integration can provide the required means to create close relationships between the user and the platform (providing a positive perception of homophily), and to promote the flow state of users as an approach to increase their exploratory behaviour.

A systematic review conducted by Tang et al. (2021) reported that most previous studies on the use of Virtual Reality (VR) environments for training purposes were performed without understanding users’ attitudes towards immersion technology. The authors argued that conclusions that are drawn without knowing the participants’ attitudes can be limited and misleading. The authors also stated that most previous review studies on VR in training and learning settings were neglecting the impact of certain environmental characteristics on users’ behaviours. Despite that the use of different learning environments in promoting
learning have been widely examined, there are large research gaps in the current literature on how VR environments can facilitate exploratory behaviour. Fabri and Gerhard (2018) reported that virtual learning environments are increasingly applying avatar identity to facilitate users’ interaction and communication with each other. Yet, the focus in recent studies has been on the use and adoption of virtual learning environments in game and non-game settings. In addition, there have been few studies that focus on how online learners approach avatar-mediated environments for learning purposes. Since promoting learners’ online experience is becoming increasingly vital to the success of educational institutions, a better understanding of the ways in which such techniques can be applied is sorely needed (Akers et al., 2020; Lukosch et al., 2019). This study attempts to further explore individuals’ online experience by empirically investigating the use of avatar-mediated environments in the online collaborative learning process. Meanwhile, this study examined a wider range of studies on the use of avatar-mediated environments in promoting flow among learners in order to broaden the theoretical basis of this discussion. We used key constructs related to avatar homophily to investigate the extent to which avatar’s background and attitude homophily would influence the exploratory behaviour of learners. We also examined the mediating role of flow experience on the relationship between avatar homophily and learners’ exploratory behaviour. This study contributes at both empirical and theoretical levels to the use of virtual learning environments by expanding knowledge on the application of avatar identity in facilitating online collaborative learning.

2 Literature review

To determine the relationships between the study variables, we used a rich foundation of theoretical research and literature on homophily and flow. Specifically, we investigated the associations between avatar homophily (background and attitude), flow experience, and exploratory behaviour in an avatar-mediated
environment (Second Life). Figure 1 shows the specific constructs, which we explained in more detail below.

2.1 The importance of homophily

Prior studies (e.g., Miller et al., 2021; Wei & Liu, 2020) have addressed the importance of homophily in promoting social and friendship relationships between individuals of the same attributes and characteristics. In an online context, the application of homophily has been also studied extensively as an essential component of relational development, especially in social networks and collaborative environments (Solomon et al., 2019; Xu & Zhou, 2020). The concept of homophily can be categorized into two main streams: attitude and background. These two elements were commonly used in the literature to justify the rate of interactions between individuals with similar and dissimilar attributes (McPherson et al., 2001). For example, people are likely to perceive background homophily when they share similar experiences, while attitude homophily can be linked to individuals’ perceptions of others’ attitudes, beliefs, and values (McCroskey et al., 2006).

According to Ladhari et al. (2020), individuals’ perceptions of homophily can be very effective in explaining their interest and behaviour in a specific context/situation. This is mainly due to the efficiency of homophily in describing how friendship pairs tend to be drawn to others they perceive as most like themselves (Noon & Meier, 2019). In a learning context, students’ perceptions of homophily with others of the same group can potentially drive their interactions and overall educational experience—regardless of their physical location when learning is conducted online. The literature, however, showed limited studies on students’ perceptions of avatar homophily in virtual learning environments. In fact, there are no evidences of how students’ perceptions of avatar homophily can influence their learning experience and behaviour in an online collaborative learning. This is important because, as Bandura (1986) suggested, individual beliefs and behaviours are communicated through interactions, those perceived similarities strengthen over time by engaging in deeper means of interaction (Aldowah et al., 2019). It is through this process that individuals of the one group can support one another and aid in the process of developing a collaborative identity (Ghazal et al., 2019). Therefore, this study considered the potential of background and attitude homophily in increasing individuals’ flow and exploratory behaviour in avatar-mediated environments.

2.2 The associations between homophily and flow

By omitting differences between group members, individuals may perceive others as more similar to themselves (e.g., sharing similar colour tone, gender, hair style, clothes, etc.). That is, they may perceive higher homophily among themselves and the avatar of other individuals in the same space. If the relationship between perceived homophily and flow experience is driven by ignoring differences among online users, then flow experience should relate to individuals’ perceptions of
homophily when their representative avatars are different, but not when they are similar. Attitude homophily can be somehow linked to the feeling of shared likeness which a person develop as a result of having similar beliefs and attitudes (Lazarsfeld & Merton, 1954). Prior research has reported a significant influence of perceived similarities with other members of an online community on their feeling of belonging to that community (Zhao et al., 2012). Prior studies have also demonstrated that information flow is likely to be activated among homophilous individuals (Brown & Reingen, 1987; Shen et al., 2016). This is mainly due to that individuals are likely to be influenced by homophilous others. According to Sharma and Rehman (2017), background homophily can help explain individuals’ perceptions of flow of information in online settings. As learners spend more and more time on online learning activities, especially during the COVID-19 area, their background and attitude homophily are becoming a fundamental pathway for information flow (Laniado et al., 2016). The same can be said to learning flow in computer-mediated environments where students meet with each other to share and solve different learning problems.

The relationship between homophily and individuals’ flow experience in computer-mediated environments has been investigated by few previous studies. For example, Hsu (2020) reported the potential impact of attitude and background homophily on flow experience through sense of belonging in order to stimulate the psychological and behavioural responses of online users when using a system. However, little is known about how avatar homophily (in terms of attitude and background) can drive their flow experience in computer-mediated environments. Based on these observations, the following hypotheses were proposed:

H1a. There is a positive relationship between avatar background homophily and individuals’ flow experience when collaborating in a virtual learning environment.
H1b. There is a positive relationship between avatar attitude homophily and individuals’ flow experience when collaborating in a virtual learning environment.

2.3 The associations between homophily and exploratory behaviour

The literature (e.g., Human-Van Eck et al., 2021; Llamero, 2014) showed that online users are commonly think of homophily as a positive heuristic when collaborating or working with others. The literature also suggested that much of the activity on the Internet involves entertainment and exploratory behaviour (Alsalem, 2019). According to Perretti and Negro (2006), status-based homophily may potentially influence the collaboration in teams of both high- and low-status members. This can also hinder or support the exploratory behaviour of team members. Individuals are likely to use homophily as a heuristic when exploring the environment in which learning from others (with similar characteristics) can lead to inefficient exploration (Calacci, 2018). This can be reasoned to that homophily promotes cooperation, social learning, and cultural bindings (Sosa et al., 2020). Despite these evidences, little is known
about how avatar homophily in terms of attitude and background can influence individuals’ exploratory behaviour in a virtual learning environment. Therefore, the following hypotheses were proposed:

H2a. There is a positive relationship between avatar background homophily and individuals’ exploratory behaviour when collaborating in a virtual learning environment.
H2b. There is a positive relationship between avatar attitude homophily and individuals’ exploratory behaviour when collaborating in a virtual learning environment.

2.4 The associations between flow and exploratory behaviour

During online learning, individuals may experience different feelings of disconnection, social isolation, distractions, boredom, and lack of control. All these feelings can result in reducing individuals’ ability to reach the state of flow (Cesari et al., 2021). Prior studies (e.g., (Krapp, 1994) have demonstrated that individuals’ feelings, interests or content-specific preferences can drive individuals’ exploratory behaviour. This assumption has been widely investigated by Novak et al. (2000) who reported an association between flow experience and exploratory behaviour. However, the mediating role of flow experience in the relationship between homophily and exploratory behaviour has not been studied in previous research. The impact of homophily on individuals’ learning has been explored in different classroom contexts (Lobel & Sadler, 2016). In addition, it is true that collaborative homophily expressed in the form of participants’ interactions and attributes can be strongly related to behavioural changes (Hristova et al., 2014). Therefore, this study proposed the following hypotheses:

H3. There is a positive mediating effect of flow experience on the relationship between avatar homophily and individuals’ exploratory behaviour when collaborating in a virtual learning environment.

3 Method

An online survey with a structured questionnaire was used to determine participants’ perceptions about how avatar homophily may influence their flow and exploratory behaviour. An online survey was used as a data collection medium. Before participating in this study, a consent form was obtained from all participants. The participants were also provided with invitation letters and information sheets regarding the study’s aim and learning activity in Second Life.
3.1 Sample and procedure

This study invited 172 students to take part in an online collaborative learning activity using an avatar-mediated environment (Second Life). Second Life is a user-created online virtual space which allows members to meet, share, and interact with others virtually. All the participants were enrolled in a first-year academic literacy course which aims at promoting student engagement, and developing academic literacies. The students were asked to take part in a series of online peer learning activities on weekly basis. The activities consisted of discussing, sharing, and documenting weekly assignments related to the reading materials provided by the facilitator (instructor). The students were randomly assigned to a peer group of three/four members. Learning spaces on the Second Life environment were used to facilitate the weekly activities. Students of the one group were able to start their virtual meetings online using their customized avatars (see Fig. 2). They were allowed to initially customize their avatars with various face parts and accessories (e.g., shirt, shoes, equipment, skin tone, and gender). After learning for 8 weeks in the Second Life environment, an online questionnaire was used to gather data on participants’ perceptions of the study variables discussed above. We were able to retrieve 157 responses from the total 172. Meanwhile, to ensure the absence of non-response biases in this study, we used the method of Ho et al. (2012). The results from the non-response bias was used to ensure that there was no difference between respondents and non-respondents.

Fig. 2 The Second Life environment
3.2 The second life environment

The Second Life environment has a vast space which makes it suitable for creating specific types of learning spaces to promote different types of student interaction. The environment allows the user to share and exchange ideas via text/voice chatting. Users are able to make changes to their avatar’s appearance so that it matched their own physical appearance. In this study, we used the Second Life viewer to access the learning space/activity. The collaborative learning process in Second Life consisted of visiting popular learning spaces for the students to be able to experience how interactive and social residents are in this learning space. The front view of the avatar consisted of several identity features that are unique to virtual worlds. This includes the group tag and avatar’s profile. The profile can reveal useful information about the identity of the avatar (see Fig. 2). Students were able to view a list of users for the collaborative learning activity, as well as their favourite locations in Second Life, photos, and a short bio. The environment also allows the user to make the avatar act according to his/her identity markers.

3.3 Instrument

This study employed a 5-likert scale (strongly agree to strongly disagree) questionnaire to examine the hypotheses above. In order to estimate the degree to which students perceived similarity in both attitude and background when working together in the Second Life world, the homophily measure by McCroskey et al. (1975) was used. Items for measuring flow were adapted from Ghani and Deshpande (1994). The items capture individuals’ perceived enjoyment (n=3 items) and concentration on the task/activity (n=4 items). Exploratory behaviour in this study was assessed using 5 items from Novak et al. (2000) (see Table 2).

3.4 Data analysis

The examination of the hypotheses was carried out using the Structural Equation Modelling-Partial Least Square (SEM-PLS). SEM-PLS is a statistical tool for validating the structural model by analysing the relations between the proposed model’s constructs. Confirmatory Factor Analysis (CFA) was performed to assess the overall measurement model. The mean values of the skewness and kurtosis were smaller than the prescribed levels (skewness, 2.0 and kurtosis, 7.0), indicating no significant problems regarding the multivariate normality of the data (Muthén et al., 1987). In order for the measurement model to have a sufficiently good model fit, the ratio of the x2 value to degrees of freedom (CMIN/df) should not exceed 3. The comparative fit index (CFI), the Tucker-Lewis index (TLI), and the non-normed fit index (NNFI) should be above 0.9, while the root mean square error of approximation (RMSEA) should not exceed 0.05, as suggested by Bentler and Speckart (1979). The convergent validity of the scales was tested by using three criteria suggested by Fornell and Larcker (1981), namely: (1) all indicator loadings should be significant and be larger than 0.7; (2) construct reliability (CR) should be above 0.7; and (3) average
variance extracted (AVE) for each construct should be above 0.5. We also relied on
the discriminant validity of the scales to evaluate the proposed model based on the
standards recommended by Fornell and Larcker (1981), that is, the square root of
the AVE values from the construct should be greater than the variance any of the
inter-construct correlations.

4 Results

A total of 157 respondents (59% male and 41% female) participated in this study. All
participants were undergraduate students in their first year of study with age ranging
from 19 to 21 years. All students had a good computer literacy level (based on their
course of study) which made them suitable candidates for this study. All the students
were involved in an online collaborative learning activity through the course of their
study. The following sections describes the evaluation results of measurement and
structural model.

4.1 Evaluation of the measurement model

The results of the CFA ($x^2 = 327.216$, $x^2$/df = 1.136, TLI = 0.985, CFI = 0.987,
NFI = 0.906, RMSEA = 0.023) showed that the hypothesized model fitted the data
and was suitable for structural modelling. Based on the correlations and discrimi-
nant validity result shown in Table 2, all the factor loadings for all items exceeded
the recommended level of 0.7. The obtained CR values for each construct (ranging
from 0.792 to 0.856) exceeded the generally accepted value of 0.70. In addition, the
AVE values (ranging from 0.560 to 0.664) exceeded the generally accepted value of
0.5. Hence, all three conditions for convergent validity were met as discussed ear-
erlier. Tables 1 and 2 presents the correlation results between the constructs with the
square root of the AVE on the diagonal. The obtained results reveal that the AVE
value for each construct was greater than the correlation coefficient of all the other
constructs in the model. This suggests that all the indicators demonstrated a satisfac-
tory convergent and discriminant validity.

| Variables | M   | SD  | Min | Max | Median | Skewness | 1 [BH] | 2 [AH] | 3 [F] | 4 [EB] |
|-----------|-----|-----|-----|-----|--------|-----------|-------|-------|-------|-------|
| 1 [BH]    | 4.31| 0.43| 2.45| 5.00| 4.13   | 0.32      | 0.766 |       |       |       |
| 2 [AH]    | 3.89| 1.03| 2.17| 5.00| 3.94   | 0.61      | 0.181 | 0.757 |       |       |
| 3 [F]     | 4.32| 0.12| 2.11| 5.00| 4.43   | 0.45      | 0.159 | 0.419 | 0.749 |       |
| 4 [EB]    | 4.11| 0.32| 2.34| 5.00| 4.50   | 0.82      | 0.221 | 0.239 | 0.290 | 0.745 |

*BH Background Homophily, AH Attitude Homophily, F Flow, EB Exploratory Behaviour*
### Table 2 Results from the test of measurement model, reliability, and validity

| Dimension                                      | Loadings | CR    | AVE  | Cranach α   |
|------------------------------------------------|----------|-------|------|-------------|
|                                                | (>0.70)  | (>0.70) | (>0.50) | (>0.70)     |
| Background homophily                           | 0.810    | 0.687 | 0.809 | Modified from McCroskey et al. (1975) |
| My peer has status like mine in this environment | 0.809    |       |       |             |
| My peer is from a different social class       | 0.758    |       |       |             |
| My peer is culturally different                | 0.729    |       |       |             |
| My peer has an economic situation like mine    | 0.763    |       |       |             |
| Attitude homophily                             | 0.802    | 0.594 | 0.803 | Modified from McCroskey et al. (1975) |
| My peer is like me                            | 0.771    |       |       |             |
| My peer is different from me                   | 0.721    |       |       |             |
| My peer things like me                         | 0.780    |       |       |             |
| My peer doesn't behave like me                 | 0.811    |       |       |             |
| Flow                                           | 0.793    | 0.621 | 0.793 | Adapted from Ghani and Deshpande (1994) |
| This environment is interesting                | 0.746    |       |       |             |
| This environment is exciting                   | 0.780    |       |       |             |
| This environment is enjoyable                  | 0.721    |       |       |             |
| I am deeply engrossed in the activity          | 0.801    |       |       |             |
| I am absorbed intensely in the activity        | 0.773    |       |       |             |
| My attention is focused on the activity        | 0.700    |       |       |             |
| I concentrate fully on the activity            | 0.827    |       |       |             |
| I am deeply engrossed in the activity          | 0.801    |       |       |             |
| I am absorbed intensely in the activity        | 0.773    |       |       |             |
| My attention is focused on the activity        | 0.700    |       |       |             |
| I concentrate fully on the activity            | 0.827    |       |       |             |
| Exploratory behaviour                          | 0.790    | 0.556 | 0.788 | Modified from Novak et al. (2000) |
| I like to browse the environment and find out about the learning activity | 0.764 |     |       |             |
| I often click on objects in this environment just out of curiosity | 0.727 |     |       |             |
| Dimension                                                  | Loadings | CR   | AVE | Cranach α |
|------------------------------------------------------------|----------|------|------|-----------|
| I usually browse or explore this environment without a specific goal in mind | 0.791    |      |      |           |
| I enjoy browsing this environment to see what is out there | 0.746    |      |      |           |
| I like to click on objects in this environment just because it looks interesting | 0.726    |      |      |           |
The first step in model estimation involved examining the goodness of fit of the hypothesized model. The structural model yielded a $\chi^2$ value of 271.861 with 231 degrees of freedom ($\chi^2/df = 1.177$). All fit indices of the structural model were satisfactory (CFI = 0.986, TLI = 0.983, NFI = 0.912, RMSEA = 0.026). In addition, the results of the analysis of the final structural model, including path coefficients, path significances, and variance explained (R) values for each dependent variable, are presented in Table 3 and Fig. 3.

The second step in model estimation involved examining the significance of each hypothesized path in the research model. The results showed that both background and attitude homophily were positively correlated with individuals’ flow experience and exploratory behaviour. In addition, individuals’ flow experience was found to be positively correlated with the development of their exploratory behaviour.

### 5 Discussion and implications

The results showed a number of significant relationships between the study variables. Individuals’ perception of avatar homophily was found to be associated with their flow experience while working in a group. Precisely, we found that users’ flow experience...
experience can be influenced by the function of perceived background and attitude homophily in an avatar-mediated environment. This finding is supported by Ho and Kuo (2010) who described the role of personal attitudes and background (e.g., personality, gender, and age) in facilitating a successful online learning outcome. Meanwhile, it is assumed that individuals’ perception of avatar attitude and background can influence the degree of their knowledge transfer in virtual learning environments. The same can be also said for learners’ motivation and engagement. For example, it is believed that this has been evident by many previous studies (e.g., Prasetyanto, Rizki, & Sunitiyoso, 2022; Abdul-Sattar & Al-Samarrayie, 2021) that examined the impact of personal attitude on learners’ motivation to learn online. This can be also attributed to the fact that individual motivation is driven by ability and effort beliefs, which in turn are mostly affected by perception and social background (Wolz, Bergande, & Brune, 2022). For example, the presence of attitude with flow cues can result in a dramatic shift in control strategy of users (Bachelor & Hansman, 1997), thus facilitating users’ actions and learning processes. Moreover, avatar homophily in SL might have contributed to learners’ knowledge transfer and retention as compared to static, non-controlled, and non-personalized environments. Based on this, it can be concluded that an increase in learners’ flow can be due to the homological attributes of avatar as a result of the increase in the amount of attention paid, thus increased memory retention and engagement.

Flow experience was found to mediate the relationship between avatar homophily and exploratory behaviour. According to Liu (2021), when an individual experiences flow, he/she is likely to deeply engage with the activity through exploring how the surrounding elements make them immersive. It is also possible that flow experience enabled learners to have stronger participation in the online collaborative process, which generates curiosity and motivates the learner to learn (Moye, 2021). This finding adds to prior studies on flow theory, for example Park et al. (2010), in that it shows how the flow state can potentially mediate individual motivation through avatar homophily (e.g., attitude and background) and behaviour in a computer-mediated environment. The finding also supports the work of Huang et al. (2010) on the role of avatar-mediated environments in stimulating individual flow experience in a context specific manner by elements of homophily that are most predictive of relationship development.

The results also showed significant relationships between avatar homophily and learners’ exploratory behaviour. Learners’ behaviour to explore new learning contents in the Second Life environment was influenced by the attitude and background of the virtual avatar of other users and the virtual content at the same time. This finding supports the assumption made by Hoppe et al. (2021) and Bond and Lenheney (2021) about the potential of using avatar customization techniques in offering an effective way to increase social presence for local or remote collaboration. According to Jin and Park (2009), users’ interpersonal involvement with their avatar may increase their ability to form a social relationship with their virtual self. Therefore, it is likely that the positive perception of avatar homophily had motivated learners to further explore the learning content as a result of their active association with objects.
Findings from this study offers sufficient theoretical and practical implications related to the use of avatar-mediated environments in a learning context. From a theoretical perspective, this study offers a conceptual understanding of the relationships between homophily and individual’s flow state. This study also adds to the current knowledge of flow theory by identifying conditions under which certain elements of homophily (e.g., attitude and background) can directly and indirectly influence the learning experience of individuals. Users’ perceived avatar’s homophily when working with others can contribute to the formation of social learning theories (e.g., Vygotsky, 1980) through the creation of desirable social conditions for users to interact and progress in the task. From a practical perspective, this study offers designers and developers of virtual environments with key insights about the role of avatar customization mechanisms in shaping users’ perceptions of homophily through appearance, movement, and control.

6 Limitations and future works

Despite the importance of the discussed findings, a number of limitations can be noted in this study. For example, this study was limited to undergraduate students from one public university which makes findings less generalizable to other demographic background and level of studies. In addition, this study was limited to the use of Second Life as an avatar-mediated environment where perceived attitude and background homophily of avatar were examined. The impact of students’ gaming profile on their flow experience and exploratory behaviour was not examined in this study which may influence the current results. Based on these limitations, future studies can further explore differences in individuals’ exploratory behaviour through the game-likeness ratings. Also, future work can consider the use of other virtual environments in facilitating learners perceived homophily and flow experience. Other flow-related antecedents (e.g., challenge/skill challenge, interaction, and control), experience (e.g., telepresence, concentration, and enjoyment), and consequences (e.g., learning and creativity) can be further investigated in the future. This study also encourages future studies to examine the application of avatar-mediated environments, from both attitude and background homophily, in promoting flow learning of learners from a wider demographic background.

7 Conclusion

This study examined how an avatar-mediated environment contribute to the relationships between avatar homophily (background and attitude), flow experience, and exploratory behaviour. The analysis results showed that perceived background and attitude homophily in an avatar-mediated environment can potentially increase users’ flow experience. The association between avatar homophily and learners’ exploratory behaviour was found to be mediated by flow experience. Findings from this work offers educational decision makers new insights into the use
of avatar-mediated environments in facilitating collaborative learning activities. The findings also enrich the current literature on the use of virtual avatars to increase the exploratory behaviour of learners through increasing individuals’ flow experience.

**Declarations**

**Conflict of interest** None.

**References**

Abdul-Sattar, M., & Al-Samarraie, H. (2021). Influence of coach’s interpersonal attraction and homophily on youth soccer players’ motivation. *German Journal of Exercise and Sport Research, 51*(1), 63–70.

Adedoyin, O. B., & Soykan, E. (2020). Covid-19 pandemic and online learning: The challenges and opportunities. *Interactive Learning Environments, 2*(2), 1–13.

Akchelov, E., & Galanina, E. (2016). Virtual World of Video Games. In *2016 8th International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES)* (pp. 1–4). IEEE.

Akers, J., Zimmernann, J., Trutoiu, L., Schowengerdt, B., & Kemelmacher-Shlizerman, I. (2020). Mixed reality spatial computing in a remote learning classroom. In *Symposium on Spatial User Interaction* (pp. 1–3).

Alalwan, N., Cheng, L., Al-Samarraie, H., Yousef, R., Alzahrani, A. I., & Sarsam, S. M. (2020). Challenges and prospects of virtual reality and augmented reality utilization among primary school teachers: A developing country perspective. *Studies in Educational Evaluation, 66*(1), 1–12.

Aldowah, H., Al-Samarraie, H., & Fauzy, W. M. (2019). Educational data mining and learning analytics for 21st century higher education: A review and synthesis. *Telematics and Informatics, 37*, 13–49.

Alsalem, F. (2019). Why do they post? Motivations and uses of Snapchat, Instagram and Twitter among Kuwait college students. *Media Watch, 10*(3), 550–567.

Atzmueller, M., & Lemmerich, F. (2018). Homophily at academic conferences. In *Companion Proceedings of The Web Conference 2018* (pp. 109–110).

Bachelder, E. N., & Hansman, R. J. (1997). Experimental study of helmet-mounted display attitude and flow cues on rotorcraft hover performance. In *16th DASC. AIAA/IEEE Digital Avionics Systems Conference. Reflections to the Future. Proceedings* (Vol. 2, pp. 6–3). IEEE.

Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of Social and Clinical Psychology, 4*(3), 359–373.

Bentler, P. M., & Speckart, G. (1979). Models of attitude–behavior relations. *Psychological Review. Psychological Review, 86*(5), 452.

Bond, W. F., & Letheney, A. J. (2021). Virtual environments for education in healthcare. In *Comprehensive healthcare simulation: Emergency medicine* (pp. 103–114). Springer.

Brown, J. J., & Reingen, P. H. (1987). Social ties and word-of-mouth referral behavior. *Journal of Consumer Research, 14*(3), 350–362.

Calacci, D. D. M. (2018). Network exploration effects in machine and human groups (Doctoral dissertation, Massachusetts Institute of Technology).

Cesari, V., Galgani, B., Gemignani, A., & Menicucci, D. (2021). Enhancing qualities of consciousness during online learning via multisensory interactions. *Behavioral Sciences, 11*(5), 57–67.

Csikszentmihalyi, M. (2000). *Beyond boredom and anxiety*. Jossey-Bass.

Fabri, M., & Gerhard, M. (2018). The virtual student: User embodiment in virtual learning environments. In *International perspectives on tele-education and virtual learning environments* (pp. 32–55). Routledge.
Ghani, J. A., & Deshpande, S. P. (1994). Task characteristics and the experience of optimal flow in human—Computer interaction. *The Journal of Psychology, 128*(4), 381–391.

Ghazal, S., Al-Samarraie, H., & Wright, B. (2019). A conceptualization of factors affecting collaborative knowledge building in online environments. *Online Information Review, 44*(1), 62–89.

Ho, L.-A., & Kuo, T.-H. (2010). How can one amplify the effect of e-learning? An examination of high-tech employees’ computer attitude and flow experience. *Computers in Human Behavior, 26*(1), 23–31.

Ho, L.-A., Kuo, T.-H., & Lin, B. (2012). The mediating effect of website quality on internet searching behavior. *Computers in Human Behavior, 28*(3), 840–848.

Hoppe, A. H., van de Camp, F., & Stiefelhagen, R. (2021). ShiSha: Enabling shared perspective with face-to-face collaboration using redirected avatars in virtual reality. *Proceedings of the ACM on Human-Computer Interaction, 4*(CSCW3), 1–22.

Hristova, D., Musolesi, M., & Mascolo, C. (2014, May). Keep your friends close and your facebook friends closer: A multiplex network approach to the analysis of offline and online social ties. In *Proceedings of the International AAAI Conference on Web and Social Media* (Vol. 8, No. 1, pp. 206–215).

Hsu, C.-L. (2020). How vloggers embrace their viewers: Focusing on the roles of Para-social interactions and flow experience. *Telematics and Informatics, 49*, 101364.

Huang, Y.-C., Backman, S. J., & Backman, K. F. (2010). Student attitude toward virtual learning in second life: A flow theory approach. *Journal of Teaching in Travel & Tourism, 10*(4), 312–334.

Eck, H. V., Pentz, C., & Beyers, T. (2021). Influencers on Instagram: The influence of disclosure, followers and author heuristic on source credibility. In *Digital Marketing & eCommerce Conference* (pp. 291–304). Springer.

Jin, S.-A. A., & Park, N. (2009). Parasocial interaction with my avatar: Effects of interdependent self-construal and the mediating role of self-presence in an avatar-based console game, Wii. *CyberPsychology & Behavior, 12*(6), 723–727.

Krapp, A. (1994). Interest and curiosity. The role of interest in a theory of exploratory action. In *Curiosity and exploration* (pp. 79–100). Springer.

Ladhari, R., Massa, E., & Skandrani, H. (2020). YouTube vloggers’ popularity and influence: The roles of homophily, emotional attachment, and expertise. *Journal of Retailing and Consumer Services, 54*, 102027.

Laniado, D., Volkovich, Y., Kappler, K., & Kaltenbrunner, A. (2016). Gender homophily in online dyadic and triadic relationships. *EPJ Data Science, 5*, 1–23.

Lazarsfeld, P. F., & Merton, R. K. (1954). Friendship as a social process: A substantive and methodological analysis. *Freedom and Control in Modern Society, 18*(1), 18–66.

Li, B. J., Ratan, R., & Lwin, M. O. (2021). Virtual game changers: How avatars and virtual coaches influence exergame outcomes through enactive and vicarious learning. *Behaviour & Information Technology, 1*(1), 1–15.

Liu, T. (2021). The freedom of binge gaming or technologies of the self? Chinese enjoying the game werewolf in an era of hard work. *Chinese Journal of Communication, 14*(2), 176–192.

Llamero, L. (2014). Conceptual mindsets and heuristics in credibility evaluation of e-word of mouth in tourism. *Online Information Review, 38*(7), 954–968.

Lobel, I., & Sadler, E. (2016). Preferences, homophily, and social learning. *Operations Research, 64*(3), 564–584.

Lukosch, H., Broekhans, B., & Gordijn, J. (2019). Effects of using avatars in a game-based learning environment. In *13th European Conference on Games Based Learning, ECGBL 2019*.

Mahfouz, A. Y., Joonas, K., & Opara, E. U. (2020). An overview of and factor analytic approach to flow theory in online contexts. *Technology in Society, 61*, 101228.

McArthur, V. (2017). The UX of avatar customization. In *Proceedings of the 2017 CHI conference on human factors in computing systems* (pp. 5029–5033).

McCroskey, J. C., Richmond, V. P., & Daly, J. A. (1975). The development of a measure of perceived homophily in interpersonal communication. *Human Communication Research, 1*(4), 323–332.

McCroskey, J. L., McCroskey, J. C., & Richmond, V. P. (2006). Analysis and measurement of the measurement of interpersonal attraction and homophily. *Communication Quarterly, 54*(1), 1–31.

McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology, 27*(1), 415–444.

Miller, B. L., Lowe, C. C., Kaakinen, M., Savolainen, I., Sirola, A., Stogner, J., Ellonen, N., & Oksanen, A. (2021). Online peers and offline highs: An examination of online peer groups, social media Homophily, and substance use. *Journal of Psychoactive Drugs, 1*(1), 1–10.
Monahan, T., McArdle, G., Kilbride, J., Mangina, E., & Bertolotto, M. (2005). Collaborative m-learning using agents and virtual reality. *Mobile learning anytime everywhere, 135*.

Moye, J. N. (2021). *Learning experience*. Emerald Publishing Limited.

Muthén, B., Kaplan, D., & Hollis, M. (1987). On structural equation modeling with data that are not missing completely at random. *Psychometrika, 52*(3), 431–462.

Noon, E. J., & Meier, A. (2019). Inspired by friends: Adolescents’ network homophily moderates the relationship between social comparison, envy, and inspiration on Instagram. *Cyberpsychology, Behavior and Social Networking, 22*(12), 787–793.

Novak, T. P., Hoffman, D. L., & Yung, Y.-F. (2000). Measuring the customer experience in online environments: A structural modeling approach. *Marketing Science, 19*(1), 22–42.

Ottiger, B., Van Wegen, E., Keller, K., Nef, T., Nyffeler, T., Kwakkel, G., & Vanbellingen, T. (2021). Getting into a “flow” state: A systematic review of flow experience in neurological diseases. *Journal of Neuroengineering and Rehabilitation, 18*(1), 1–21.

Pan, Y., & Steed, A. (2019). How foot tracking matters: The impact of an animated self-avatar on interaction, embodiment and presence in shared virtual environments. *Frontiers in Robotics and AI, 6*(1), 104–123.

Park, B., Ahn, S., & Kim, H. (2010). Blogging: Mediating impacts of flow on motivational behavior. *Journal of Research in Interactive Marketing, 4*(1), 6–29.

Pan, Y., & Steed, A. (2019). How foot tracking matters: The impact of an animated self-avatar on interaction, embodiment and presence in shared virtual environments. *Frontiers in Robotics and AI, 6*(1), 104–123.

Prasetyanto, D., Rizki, M., & Suntitoyoso, Y. (2022). Online learning participation intention after COVID-19 pandemic in Indonesia: Do students still make trips for online class? *Sustainability, 14*(4), 1982.

Perretti, F., & Negro, G. (2006). Filling empty seats: How status and organizational hierarchies affect exploration versus exploitation in team design. *Academy of Management Journal, 49*(4), 759–777.

Procter, L. (2021). I am/we are: Exploring the online self-avatar relationship. *Journal of Communication Inquiry, 45*(1), 45–64.

Prasetyanto, D., Rizki, M., & Suntitoyoso, Y. (2022). Online learning participation intention after COVID-19 pandemic in Indonesia: Do students still make trips for online class? *Sustainability, 14*(4), 1982.

Perretti, F., & Negro, G. (2006). Filling empty seats: How status and organizational hierarchies affect exploration versus exploitation in team design. *Academy of Management Journal, 49*(4), 759–777.

Procter, L. (2021). I am/we are: Exploring the online self-avatar relationship. *Journal of Communication Inquiry, 45*(1), 45–64.

Sharma, S., & Rehman, A. (2017). Impact of social relationships on electronic word of mouth in social networking sites: A study of Indian social network users. *International Journal of Electronic Marketing and Retailing, 8*(2), 93–115.

Shen, X. L., Zhang, K. Z., & Zhao, S. J. (2016). Herd behavior in consumers’ adoption of online reviews. *Journal of the Association for Information Science and Technology, 67*(11), 2754–2765.

Sibilla, F., & Mancini, T. (2018). I am (not) my avatar: A review of the user-avatar relationships in massively multiplayer online worlds. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace, 12*(3), article 4.

Solomon, R. S., Srinivas, P., Das, A., Gamback, B., & Chakraborty, T. (2019). Understanding the psychosociological facets of homophily in social network communities. *IEEE Computational Intelligence Magazine, 14*(2), 28–40.

Sosa, S., Sueur, C., & Puga-Gonzalez, I. (2020). Network measures in animal social network analysis: Their strengths, limits, interpretations and uses. *Methods in Ecology and Evolution, 12*(1), 10–21.

Tang, Y. M., Chau, K. Y., Kwok, A. P. K., Zhu, T., & Ma, X. (2021). A systematic review of immersive technology applications for medical practice and education-trends, application areas, recipients, teaching contents, evaluation methods, and performance. *Educational Research Review, 35*(1), 100429.

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*. Harvard university press.

Wei, L., & Liu, B. (2020). Reactions to others’ misfortune on social media: Effects of homophily and publicness on schadenfreude, empathy, and perceived deservingness. *Computers in Human Behavior, 102*, 1–13.

Wolz, S., Bergande, B., & Brune, P. (2022). Influence factors on students motivation in introductory programming lectures of computer science non-majors. *Cogent Education, 9*(1), 2054914.

Xu, S., & Zhou, A. (2020). Hashtag homophily in twitter network: Examining a controversial cause-related marketing campaign. *Computers in Human Behavior, 102*(1), 87–96.

Zhao, L., Lu, Y., Wang, B., Chau, P. Y., & Zhang, L. (2012). Cultivating the sense of belonging and motivating user participation in virtual communities: A social capital perspective. *International Journal of Information Management, 32*(6), 574–588.

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