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Designing a game-based collaborative revision in a 2D virtual world for South Asian IT undergraduates

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Abstract

This study explores Sri Lankan undergraduate students' perceptions and experiences in using a 2D virtual world to support self-paced and collaborative revision activity. Using a game-based approach, a scavenger hunt activity was designed for the students to practice first-year content while working collaboratively or individually. To explore students' experiences observations, focus groups and feedback surveys were used with a focus on their collaborative participation and using the virtual environment for self-paced engagement. The study is underpinned by Social Constructivism while incorporating Self-regulated learning. To design the activity, game-based learning and quest-based learning was used. The findings indicate that students felt the game-based approach was motivational to engage in a revision activity. Further, their collaboration was higher in the virtual space compared to in-person. Students highlighted the affordances of the virtual world, such as anonymity and psychological safety, which supported active collaboration and inclusive learning styles. Some students used persistent nature of the virtual environment to engage at their own pace and independently highlighting self-paced learning. This study contributes by sharing how 2D virtual world supports delivering a game-based revision activity that provides opportunity for the students to participate through self-paced and collaborative engagement in a South Asian context.

Keywords 2D virtual worlds, Game-based learning, Collaboration, Self-paced engagement

1 Introduction

Students struggle to understand the concepts if they do not remember the foundational knowledge. In higher education, students being responsible for their learning is a cornerstone [33]. In a South Asian context, such as Sri Lanka, challenges arise when students transition from one level of study to the next (from school to higher education). They expect teachers to provide all the necessary information at each level, rather than requiring them to retain it [36]. This highlights that due to the rote learning experience in schools; students do not understand the importance of being independent and responsible to retain foundational knowledge.



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Due to the workload, lecturers use traditional revision methods, such as tutorials, take-home assignments, and pre-session activities. However, these approaches are not productive in retaining the knowledge due to passive engagement [13]. Due to pressure built up related to take-home assignments, they can be considered as not inclusive learning approaches [5]. Further, it is concerning whether these assessments promote authentic and productive learning [20]. Conversely, using activities that encourage engagement, and interest can be supportive for the students to retain knowledge [25]. Collaborative learning is a widely used learning approach which is grounded in Social Constructivism [47]. Social Constructivism theory expresses that interactions can be created through negotiations, discussions, and collaborations [19, 38]. In a learning environment, Social Constructivism supports the development of interactions between teachers and students, as well as among students themselves. Hence, Social Constructivism is an opportunity that assists students and teachers in sharing knowledge. Experienced and knowledgeable learners or teachers can disseminate their knowledge, skills, and experiences to other inexperienced learners [27]. However, the concern is that South Asian students are passive in sharing ideas and engaging in open interaction with their peers [43, 51].

Digital technologies like 3 Dimensional (D) virtual worlds have been popular and identified as collaborative spaces. However, due to digital divide, poor infrastructure and financial limitations, 3D virtual worlds are unapproachable for developing countries [37]. On the other hand, 2D virtual worlds are more accessible for such a context, and they provide collaborative work without any specialised resources [29]. Studies have shown that avatar-based interaction promotes active engagement [4], and incorporating game-based elements fosters motivation to engage [35].

This study applied a game-based approach (scavenger hunt) in Second Life to explore how first-year IT students at a Sri Lankan Higher Education Institute (HEI) work collaboratively and at their own pace in a revision activity. Inherently, Second Life is a 3D virtual world. For this study Second Life was run in a browser (without any specialised resources) where the virtual content was viewed in a 2D perspective. The following research questions guide the exploration of the situation in detail.

- How do students engage with a 2D virtual world for self-paced revision activity?
- How do the affordances of a 2D virtual world influence collaborative engagement during the revision activity?
- What are students' perceptions of using a 2D virtual world for a game-based revision activity?

2 Background

Virtual worlds can be 2D or 3D online environments where participants can work together, communicate and share experiences through an avatar [23, 24]. Bach and Thiel [4], Alahuhta et al. [2] and Hakonen and Bosch-Sijtsema [26] have stated that avatars give psychological safety for the participants. Avatars can use an anonymous name to represent the physical character in the virtual environment, which can provide a psychological shield for the participants since their identity is hidden.

The use of virtual environments in educational contexts has increased, with more literature focusing on 3D virtual environments [44]. This can be due to the immersive experience gained from the 3D virtual environments. However, using 3D virtual worlds

in the South Asian context can be difficult due to infrastructure and financial limitations [37, 45]. Even though 2D virtual worlds cannot be compared with the above immersive experience, they can be a useful approach to design authentic activities with limited resources [29].

Berns et al. [6] highlighted that virtual world environments are supportive in building problem-based, game-based, experimental, role-playing or task-based activities for learning. Willingness to engage in collaborative work can be fostered through the rich graphics environments and immersive qualities of virtual worlds. Further, virtual worlds are persistent [32], which facilitates students to rehearse and engage in the activity without location or time limitations. This support self-paced learning opportunities for the students. Multimodal communication is available in virtual world environments [11]. Therefore, students can use both textual and verbal methods to communicate. Scullion et al. [40] argue that virtual worlds can be developed into interactive environments, leading to creative, collaborative learning activities [40]. All these affordances of virtual worlds are supportive in developing collaborative activities. Schouten et al. [39] have experimented to explore how a group of students make decisions in an activity designed in a virtual world. They identified that the avatar-based shared environment of a virtual world is supportive of making decisions collaboratively. Ke and Lee [30] have explained that they found student engagement is high with the collaborative design in the virtual world.

In contrast to the above studies done in a Western context, Somaratne [43] highlights that in a South Asian context, such as Sri Lanka, students' engagement in collaborative work is passive. It is mainly due to the cultural practices of the Sri Lankan community that affect active engagement in collaborative work [43]. However, there is a concern about how those students' participation in a virtual space affects their learning. Hence, this study incorporated a 2D virtual space.

Game-based learning is supported in 2D virtual worlds, where virtual objects can be used to design the game. Game-based learning promotes both cognitive and social skills when students have opportunities to collaborate [1], and the motivation is high when students are expected to solve puzzles and challenges [31]. In virtual environments, learners can complete the tasks repetitively at their own pace while being responsible for their learning [41].

Considering the above, there is a gap in the literature where limited studies are on how 2D virtual worlds can be used for game-based revision activity in the South Asian context. Moreover, it is underexplored how 2D virtual game-based activities support both self-paced and collaborative engagement. This study does not measure knowledge retention of the students. Thus, the study explores students' experiences and perceptions of using a 2D virtual environment for a game-based revision activity.

3 Theoretical framework

The primary theory that underpins this study is Social Constructivism [47]. As Ruey [38] says, an individual can acquire knowledge through interactions and think independently through socially constructed learning. Unlike a student listening to a lecture, a constructivist approach creates a possibility for them to learn through collaboration. Vygotsky explained that a student's cognitive development can be fostered both individually and through peer and teacher support [18]. A student can explore or possess

the knowledge to a certain level. However, teachers can have more ideas, and some students may also possess additional knowledge, creating an opportunity for students with less or no knowledge in a particular area to receive support from teachers and their peers. This was the concept of Vygotsky's Zone of Proximal Development. Zone of each learner could be developed to a higher level when they collaborate with others [18]. Hence, the learner will be able to find answers for the unknown areas by drawing on the support from members of the group, who possess that knowledge and experience. To interpret the collaborative engagement within the virtual environment, Social Constructivism is the appropriate theory to explore how the students work collaboratively to engage in the revision activity. Thus, this study explored how students interact with their peers and these interactions are asking for help, supporting peers and solve problems collaboratively.

The study is also informed by Self-regulated learning where learners take responsibility for the learning and take active role to engage in the learning activities. Zimmerman's Self-regulated learning theory frames that learner agency happens where learners take initiative to manage their own learning, planning their actions, being responsible beyond formal education, identify and address their needs, and actively seek resources and feedback (2002). 2D virtual worlds have affordances that could provide opportunities for the learners to engage in activities independently. This study explored the affordances of the virtual world supporting study participants for self-paced engagement.

Social-constructivism and Self-regulated learning guided the interpretation of students' collaborative and self-paced engagement. For the learning activity that was designed for this purpose was guided by game-based learning principles. The study followed Dau's [17] framework for game-based learning. Thus, to design the game-based activity, it ensured that the content for the game was aligned with the learning outcomes of the first-year IT subjects. To structure the content with the game elements and how students would progress through the challenges to complete the activity, Quest-based learning was incorporated [42]. That is, for the scavenger hunt, locating objects, solving subject-specific puzzles and work collaboratively to find hints to unlock next steps were designed based on this.

Therefore, the study was underpinned by Social-constructivism while incorporating self-regulated learning, game-based learning and quest-based learning.

4 Methodology

The study used a qualitative case-study design to explore students' perceptions and experiences of the virtual game-based revision activity designed in a Sri Lankan HEI. A case-study approach is suitable to explore the social phenomena in detail [50]. The study focused on capturing engagement, perceptions and experiences of first-year IT students in a Sri Lankan HEI participating in a scavenger hunt activity designed in Second Life. The research was exploratory and descriptive, guided by the above research questions to explore the pedagogical affordance of the virtual space in the South Asian context.

The study was conducted in a Sri Lankan HEI that offers IT undergraduate programmes involving 49 first-year students. Since the participants were from a targeted cohort, convenience sampling was used [15]. This is mainly due to the ability to use common IT subjects (Programming, Database, Data Structures and Algorithms, Computer systems and Software Engineering) in the first year rather than specialising in a

particular subject. Ethical approval was obtained from the Sri Lankan HEI ethics committee, University of the West of England and followed the British Educational Research Association (BERA) Ethical Guidelines (2024). The participation was voluntary, and informed consent was obtained from the study participants. This study was not embedded in a course as it ran as an external study in 2017. Therefore, the participation was not graded. Participants worked in groups which and their work was not evaluated as it was not needed for the study to evaluate. The study wanted to explore and interpret participants engagement in the revision activity designed in a virtual space. It also ensured anonymity and confidentiality of the participants throughout the study. That is, avatars in virtual space, observations, focus groups and feedback surveys contained anonymised data [9, 23].

The learning activity was designed based on a game-based learning approach. Game-based learning can be adapted to be used in any subject. Annetta et al. [3] argue that games can allow students to learn without being limited to traditional learning methods. It can be accepted that games are used to enhance the learning skills of a learner through active engagement. Dau [17] suggests that game-based learning activities should create opportunities for students to engage playfully while completing set goals or objectives. A scavenger hunt-type game was designed in Second Life, where students navigated a virtual campus space to locate hidden tokens. Second Life is a well-established and popular virtual world for educational purposes [46]. Different learning activities are designed in Second Life, and based on previous research, it was found that Second Life encourages students' learning enthusiasm [14]. The site in Second Life used in this study was a port. This was designed by the University of the West of England for their Postgraduate course on Virtual Worlds [22]. Since the researcher for this study was enrolled at this University, they were allowed to use this site. It was a feasible option for the researcher as they could use it for free. The researcher was allowed to add the required objects for the scavenger hunt to the site. Therefore, they did not have administrative privileges to change the landscape of the environment. Once the activity was complete, the objects used in the game were removed so other participants could use the site. Therefore, it is important to highlight that this study did not explore or focus on how the landscape aligned with the IT subjects.

A token represents a question. Questions are based on foundation IT subjects (Programming, Database, Data Structures and Algorithms, Computer systems and Software Engineering) and aligned with the learning outcomes for those subjects. This approach was taken to align game elements with the subject content constructively.

The game element adopted was a quest-based learning model [42], where students engage in a scavenger hunt by solving quests (questions) and unlocking hints. The activity has 34 questions. The following figures show examples of questions and hints used in the game (the numbers indicate the sequence of actions expected to perform during gameplay).

As shown in Fig. 1, once a student clicks on Token 3 (1), they receive the question (2). Students discuss in groups to answer the question. Once they complete the question, they can use the hint (3) given in the chat to find the next question or token. The hint says to find an object named 'Stone: Input N'.

Figure 2 illustrates the object (Stone: Input N) mentioned in Fig. 1. Once the student clicks on the object, they receive instructions (2) to find next question and next hint.

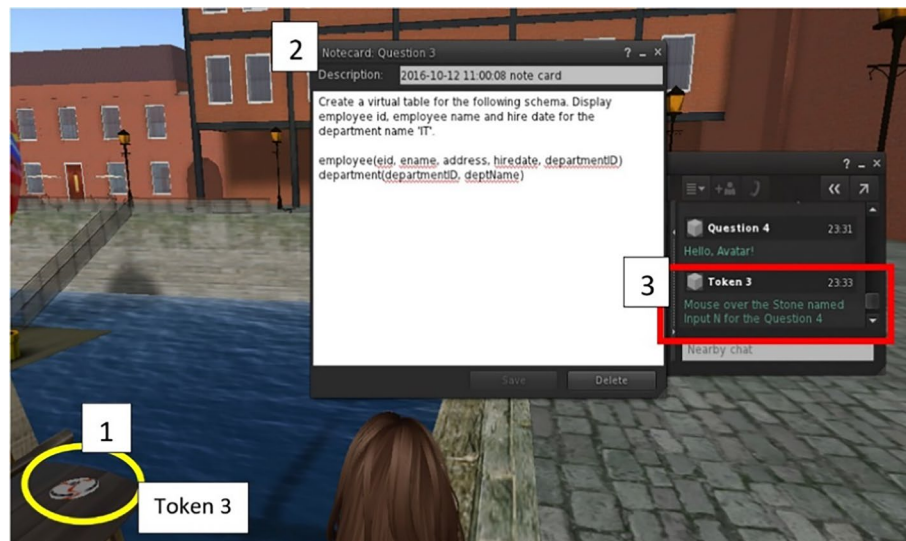


Fig. 1 Receiving question 3 after successfully finding Token 3

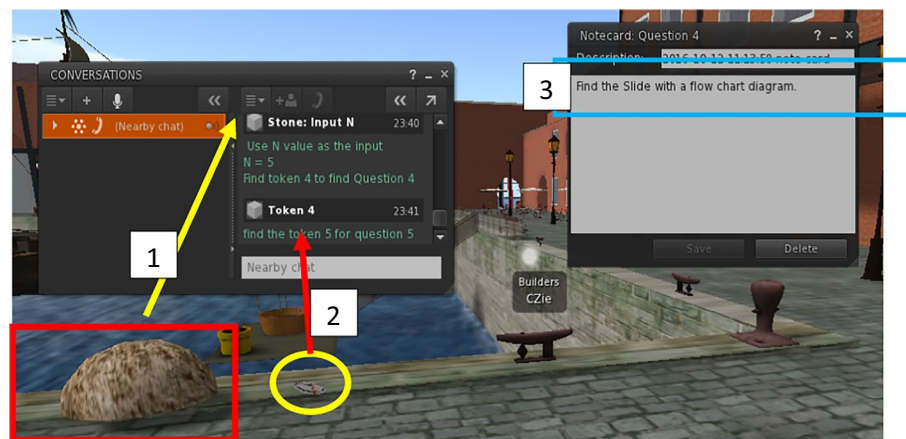


Fig. 2 Finding additional objects and tokens to solve a question

Figure 3 illustrates different approach to find the next question. When the token is clicked (1), a message (2) and the Chat (3) appear. Once the message (2) is clicked, it gives the question (4).

To reduce biases in qualitative research, various data collection tools (observations, focus groups, and feedback surveys) were incorporated.

- The observations were made by the author of the study. They contained students' collaborative behaviour and participation to solve the puzzles. Students' interactions such as helping team members, seeking help and collective decision making were observed. Further, it also captured how students used the virtual environment for self-paced engagement by observing them revisiting activities outside activity schedule to complete tasks.
- The focus groups were the same group who completed the activity. Each group comprised of three to six members. The questions were semi-structured where students shared their experiences with the team members when they were completing the activity.

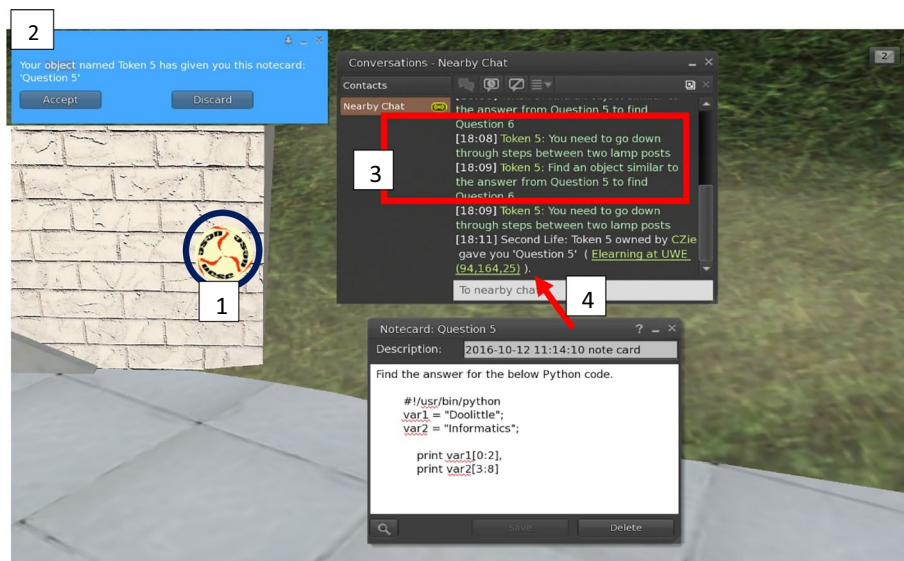


Fig. 3 Finding the next question using a solved answer

- Feedback survey comprised of qualitative questions that captured students' perceptions on using virtual environment for the activity. The perceptions were on using the virtual environment for game-based activity and opportunities to work in the tasks collaboratively and independently at their own pace.

Using data from multiple methods (an approach in triangulation), supports reducing biases [7] and improving the validity of the findings through cross-validation [10, 16]. The data is qualitative. Therefore, thematic analysis was used to analyse the data, where codes were identified, and they were mapped into broader themes [8, 34]. The initial coding was framed based on the study's theoretical framework, thus, Social Constructivism and Self-regulated learning. Therefore, the coding focused on collaborative engagement, actions taken for self-paced engagement, helping or seeking for help behaviour, taking responsibility for own learning and perceptions of the virtual world. Then the data were coded into these categories. The similar codes were then grouped into broader themes that were used to address the research questions.

5 Findings

Following are the findings of the study that answered the three research questions.

1. RQ1: How do students engage with a 2D virtual world for self-paced revision activity?
 - Theme 1: Persistent nature of the virtual space
Students emphasised the importance of being able to revisit the activity at their convenience. This is mainly to practice questions. During the observations, it was noticed that students join the virtual space outside the scheduled hours and practiced. Another student commented, *"I can come and do the questions again. They are there always. I am slow, but my group members are fast. They help me. But I want to try on my own, and it helps me to remember theory"*. This highlights that the persistent nature of the virtual environment facilitated students to revisit the activity and engage with it at their own pace.

- Theme 2: Taking responsibility for own learning

As mentioned above, joining the virtual space outside the activity schedule and going through the puzzles demonstrates their learner agency and self-paced engagement.

In this study, students' feedback and observations reflected how they become independent and responsible in their learning. A student said, *"I am shy to ask questions. The virtual space is not scary. I can move freely; I can talk or chat"*. This shows students their autonomy in engaging actively.

2. RQ2: How do the affordances of a 2D virtual world influence collaborative engagement during the revision activity?.

- Theme 3: Psychologically safe space for communication and interaction

Students commented that working in the virtual space is safe and comfortable. It is mainly because *"I can talk or chat using our avatar. I give a nickname to my avatar. It makes me think even if I make a mistake, no one knows that it is me"*. Another group of students said, *"In the classroom, you are scared to ask or say something, thinking what others would think. You can see everyone in the classroom looking at you. However, in the virtual world, our group members asked questions without being scared. No one is staring at us"*. The observations showed student avatars approaching the teacher avatar or peer avatars to request help to find a hint, clarify concepts or even guide peers to correct their mistakes.

- Theme 4: Peer support and interactions

It was not only finding hidden tokens but also solving the questions. Students worked together to solve the questions. Some students who did not know how to solve the problem requested help to teach them. At the end, they commented, *"I got help from my friends to solve the problem. Now I know how to do it on my own"*. It was also observed that some students took the initiative during the virtual activity to encourage or help others, which was not seen in the classroom. This was later confirmed during the focus group discussions, where students agreed *"Student X is always silent in the class, but they guided us to find tokens and solve some questions when we were lost"*.

- Theme 5: Influences from the culture and individual mindset

General feedback from the surveys and focus groups was that students' engagement in the virtual space was better than in the classroom. Similarly, observations done in the virtual space and the classroom supported the above statement. The main reason was the anonymity and psychological safety within the virtual space. However, some observations pointed out that some students prefer to work individually. The focus group discussions revealed that some students believe completing their assigned work and then incorporating it into the group's final product forms collaborative work.

3. RQ3: What are students' perceptions of using a 2D virtual world for a game-based revision activity?.

- Theme 6: Attractive and motivating environment

Students' actions and feedback indicated that they enjoyed working in the virtual space and playing the scavenger hunt. One feedback was *"It is nice and makes me want to do it. This is useful and not boring. If we are asked to revise by reading or watching, then I feel bored"*. Similarly, the observations indicated students' enthusiasm and motivation.

- Theme 7: Critical digital pedagogical concerns

Although learner agency is considered a positive experience, using technology for learning can also have a negative impact. Several students commented, *"Virtual space is nice, but if you use mythical creatures as your avatars, it is distracting. It is not suitable for education"*. Additionally, students said they were able to work in the virtual world when they were at the university (using university infrastructure). However, when they tried at home, some students could not use it properly due to infrastructure issues (poor internet connection or incompatible hardware).

6 Discussion

- RQ1: self-paced revision in a persistent virtual environment.

The study participants demonstrated their learner agency by being responsible when completing the task [21] even outside their allocated activity schedules. Further, a collaborative approach was appreciated, where students with limited knowledge requested or received support from their group members. Later, they confirmed that they were able to complete the tasks on their own, which indicates adherence to Vygotsky's Zone of Proximal Development [18].

Aligning with Self-regulated theory [52], the students set goals and motivated to revisit the puzzles to solve by themselves. In addition to working collaboratively, they managed their own learning by working independently in the virtual space. Further, they requested feedback from their peers to get assistance when needed.

- RQ2: Affordances of virtual world for collaboration.

Students found the virtual world less intimidating. This led to situations where students demonstrated empowerment by seeking help or sharing their knowledge. This indicates students felt psychologically safe in the virtual space due to multi-mode communications such as text and chat, use of avatars with anonymous identity and no face-to-face encounters [2, 4, 26].

Inclusive learning point-of-view [12], allowing students to select a suitable learning style for themselves is important [12]. Somaratne [43] mentioned that students' participation varies depending on the activity type. In this study, students showed a positive attitude towards the virtual space and the activity. This suggests that the virtual space and interactive elements used to design virtual learning activities can foster collaboration. However, some students did not know how to work collaboratively, yet they engaged individually. Somaratne [43] indicated that Sri Lankan students are exposed to 13 years of rote learning in their school education. When these students enter higher education and are asked to work collaboratively, they often struggle to do so effectively. The unfamiliarity with working collaboratively can be associated with the rooted

practices of the study participants, and it can be common in communities where rote learning is promoted since childhood [43].

- RQ3: Students perceptions of using virtual world to for game-based activity.

The study participants' perceptions of using the virtual world for the game-based learning activity were positive. They preferred a game-based learning activity. The scavenger hunt approach was beneficial for them to revise content in a playfully motivating way. Revision can be boring, but the game-based approach makes it more engaging and motivational [31, 42]. They were able to engage in the game-based learning activity collaboratively as well as at their own pace. Game-based learning is useful for making monotonous tasks, such as revising concepts and theory, more engaging. Their reflection was to adopt virtual worlds in the educational context with a set of defined instructions. Avoiding mythical avatars is advisable, as they negatively influence the academic atmosphere. This emphasises that even in a synthetic environment like a virtual world, students prefer a more realistic experience when used for educational purposes. Further, they highlighted that working on a 2D virtual world can be challenging due to limited or poor resource setup. Thus, this study also claims that simply embracing technology may not always be fully supported if there are inequalities in required resources or if deeply rooted cultural practices are not addressed in a context like Sri Lanka. Critical digital pedagogy in education involves learners critically reflecting on social inequalities when using educational technology for their learning [21]. Therefore, it indicates the importance of adopting the 2D virtual worlds in a culturally responsive way for South Asian regions.

7 Conclusion

This study explored how Sri Lankan undergraduate students engage with an activity designed in a 2D virtual world for self-paced and collaborative revision. The findings highlighted that the persistent nature of the virtual space facilitated self-paced engagement where students revisited the activity beyond their scheduled sessions to practice questions and go through the tasks according to their pace and need. Students appreciated the flexible and self-paced engagement, which also promoted inclusive learning.

The findings highlighted that affordances of the 2D virtual world facilitated collaborative engagement during the activity. Further, anonymity, interactions based on avatars and multimodal communication built a psychologically safe environment, and flexible engagement opportunities for the students that promotes inclusive learning space. It also indicated students' confidence in asking for help or support fellow students. However, there were situations where deeply rooted cultural practices influenced their collaboration. This suggests further investigations into how working in 2D virtual learning activities affects the deeply rooted cultural practices of South Asian students.

Using a game-based activity was well received by the students where they pointed it was enjoying and motivating approach. However, technical barriers can impact on this enthusiasm. Thus, students' critical reflection on the digital pedagogical approach highlighted the impact of adopting technologies in contexts like South Asia, which have limited technological resources.

This study contributes to research on technology-enhanced learning by showing how 2D virtual world can support both self-paced and collaborative game-based revision

activity within South Asian context. The study's limitations include the use of qualitative data and a limited number of participants from a single South Asian context. This would raise concerns about biases and generalisability. It is a common feature that qualitative research may not be generalised to all contexts. However, to reduce the biases and provide validity for the findings, triangulation was used.

Finally, this study concludes with an opportunity for future research. Thus, it suggests whether the similar revision approach used in this study can benefit in reducing the second-year slump (sophomore slump or second-year blues). The second-year slump refers to the period when undergraduate students, having progressed to their second year, either become dissatisfied with the course or experience a decline in motivation [28, 48]. Ultimately, this leads them to drop out of their courses [48]. Therefore, Whittle [49] suggested that further investigation in this area is required. Future work can explore whether the 2D virtual game-based revision activities build the confidence of the students and make them feel they are supported to complete the second year of study.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1007/s44217-026-02157-7>.

Fig 1 Receiving question 3 after successfully finding Token 3

Author contributions

This work is based entirely on the research conducted by P.S. P.S. designed the study, developed the virtual world learning activity, collected and interpreted the data, and carried out all analysis and writing.

Funding

This work did not receive funding.

Data availability

The datasets gathered and analysed during this study are not publicly available due to the agreement with the higher education institute where the study was conducted but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the University of the West of England, Faculty Research Ethics Committee (UWE REC REF No: FET.17.02.024). The study obtained consent to participate. The participation was voluntary, and informed consent was obtained from the study participants. There are no details on individuals or information that can individually identify the participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 20 February 2026 / Accepted: 8 September 2026

Published online: 30 September 2026

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