2020 IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology (WI-IAT)

2020 IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology (WI-IAT) | 978-1-6654-1924-6/20/$31.00 ©2020 IEEE | DOI: 10.1109/WIIAT50758.2020.00150

On Repurposing Social Virtual Reality Platforms to Support Distributed Learning

Shaun Bangay, Guy Wood-Bradley, Hasan Ferdous, Thuong Hoang,
Sophie Mckenzie, Alexander Baldwin and Elicia Lanham
School of Information Technology
Deakin University
Geelong, Australia
Email: {shaun.bangay; guy.woodbradley; hasan.ferdous; thuong.hoang;
sophie.mckenzie; alexander.baldwin; elicia.lanham}@deakin.edu.au

***Abstract*—We investigate repurposing existing virtual reality applications as teaching platforms. A pilot study conducted using six freely available social applications on the Oculus Quest platform investigates the practical issues involved in using these applications for distributed learning in a higher education context. Recordings and reports from collaborative sessions with each application yield insights into employing virtual reality as an environment to support teaching. First time use involves both adapting to the platform interface, but also ensuring mutual agreement on conventions, control and expressions. Several applications support limited importing and authoring of content. Addressing and locating rooms and participants is a challenge, while the opportunities associated with avatar representation and identity promise enhanced interactions between individuals beyond traditional teacher/student roles.**

***Index Terms*—virtual reality, education, social platform, avatar, identity, rooms and worlds**

I. Introduction

Alternative forms of online learning experience are important, especially in the context of a pandemic. How can we manage the transition to teaching in virtual reality (**VR**)? We describe a unique opportunity; capturing the first-time experience of a team of established university lecturers with existing expertise in the design and development of interactive virtual reality experiences as they evaluate teaching opportunities in a set of collaborative virtual environments.

Our goal, shared with many others [1, 2, 3, 4, 5], is to use virtual reality to enhance teaching in a tertiary context. We focus on the teaching environment rather than on facilitating a specific lesson or curriculum topic. Few of our previous teaching activities could be immediately accommodated in VR due to hardware, software and logistical constraints. An opportunity has arisen with the Oculus Quest: a versatile and relatively inexpensive virtual reality headset. This investigation describes the team's initial use of this device, and the freely available social platforms that it supports, to determine features that would be desirable in a flexible virtual reality teaching environment.

A. Approach

A positive initial experience is crucial for teachers and students to adopt VR for education. This evaluation focuses on an opportunity for lecturers to capture the first experience of a new hardware platform, interacting and collaborating in VR on a shared journey of discovery. The team made a conscious choice to capture and report on this experience from an 'expert' student perspective while also considering the needs of educators for such a platform. This approach is deliberately distinct from the other research methods, using comparative application review or student experience evaluations, that critically review VR experience.

The goal is to identify opportunities in existing VR applications to support flexible teaching and learning activities. We utilize social VR applications, typically intended for gaming, that have already been engineered to encourage levels of engagement that would be desirable in a teaching environment. The philosophical principle is to 'repurpose a popular application for education, rather make an educational application popular', much as games are often employed as teaching tools [6]. Six third-party applications are tested to identify trends and opportunities. Our immediate need is for a single VR platform able to support day-to-day teaching practices across multiple teaching modules, much as the sandbox environment provided by Minecraft has been adapted to teach topics from mathematics, geography and cultural heritage [7] to collaboration and problem solving [8]. We further hypothesize that these environments should facilitate dynamic human interaction for learning, rather than a scripted experience.

The approach used is based on an expert review, with concessions to the exploratory nature of the investigation. Session were recorded, transcribed and combined with a post-session report before themes were identified using automated thematic analysis [9]. Common themes were then reviewed by the team to derive the insights reported.

II. Literature review

The use of virtual and augmented reality in its various forms for education is a popular and rapidly developing topic [2]. Students and teachers often demonstrated reluctance and concerns about the perceived value about the use of VR [2, 10]. Lack of a pedagogical model [11] poses a significant challenge. Managing the equipment required is an issue [2, 12], although VR devices can potentially 'replace'

978-1-6654-1924-6/20/$31.00 ©2020 IEEE
DOI 10.1109/WIIAT50758.2020.00150

other complex laboratory equipment with its virtual representation [1, 13, 5]. Despite these problems, VR is being for constructivist teaching [11] in specialist areas such as medical training [2, 3, 4], archaeology [5] and engineering [1]. General purpose educational VR applications would allow content to be adapted or replaced to match topics being taught [1]. Teaching of VR topics itself is typically conducted outside of virtual reality, but with opportunities to creatively utilize the equipment [12]. A hazard with VR educational practice is the attempt to recreate existing classroom settings, including room with screen, in the virtual world [1], or providing restrictive rule-bound simulations suited to only one purpose [1]. Rather VR should be used appropriately, such as by exploring fieldwork environments inaccessible in the classroom [5, 10], and employing haptics to provide relevant feedback, by exploiting affordances supporting additional learning strategies and collaborations [14, 11] or engaging with game-based approaches [5]. Social presence in VR classes encourages engagement and collaboration compared to other forms of distance teaching [15].

Evaluation of VR teaching environments often focuses on the student experience, and typically on a comparative evaluation of educational outcomes relative to a control scenario [1, 15]. This fails to consider the role of the teacher during the interaction [1] and opportunities for instruction and social construction [11]. VR based teaching is reported as being more effective and engaging [13, 16], although the educational advantages are not uncontested [3]. Just using a head-mounted display to display views of a 3D object is likely insufficient to fully utilize VR to develop critical thinking skills [13, 14, 5]. A focus on representational fidelity and learner interaction obscures opportunities such as identity construction and conceptual immersion [11] through avatar embodiment. Issues with hardware and software in VR can also detract from the learning experience [14] and this needs to be continually evaluated as technologies improve.

This section identifies a need for a teacher led evaluation of contemporary VR environments in order to identify how these could be used as flexible teaching platforms.

III. Method

The Oculus Quest is a mobile headset with no wires attached, includes a pair of handheld controllers, and can be used seated in a physical classroom or in larger indoor or outdoor areas. Outward facing cameras capture position and orientation of head and hands, and the external environment.

The selection criteria for the applications chosen are: support for multiple participants in a common virtual world, allowing teachers and students to interact synchronously, and free to install and use so that they are easily accessible to students. At the time the evaluation was performed (December, 2019) the qualifying applications available for the Quest via the Oculus store was limited to: **Rec Room** (https://recroom.com/), **VR Chat** (https://vrchat.com/), **Altspace VR** (https://altvr.com/), **BigScreen** (https://www.bigscreenvr.com/), **Epic Roller Coasters** (http://b4t.games/), and **PokerStars VR** (https://www.pokerstars.com/poker/ps-vr/). These all include elements of social interaction, recreational entertainment and game play in various proportions.

Each application was used for approximately 2 hours per application. A random subset of the team participated in each session, with some members participating in several sessions while others joined only one.

A typical session would consist of: getting everybody registered, exploration of the 'home' space and the basic facilities provided for social interaction, and then visiting a selection of the featured areas within the application (such as custom worlds or particular activities around specific goals). Beyond the open-ended directive to assess relevance as a teaching environment, participants were free to direct their focus as they see fit. The explicit goal for each session was to assess the suitability of the platform for teaching activities.

The sessions were run using a separate video-conference call to coordinate team members. Recordings were made both of the video call and the view of the VR session from the perspective of one of the team members. Recordings are transcribed by a speech to text system (https://azure.microsoft.com/en-us/services/cognitive-services/speech-to-text/). A formal report is also prepared by some team members in each session. This specifically probes topics including: summary of the session, features supporting teaching opportunities, issues with the hardware and software, feasibility as a teaching platform, and issues associated with teaching in such a space. The transcribed session recordings and reports are subject to automated thematic analysis and the top themes identified are discussed in a team reflection session to produce the recommendations provided in section V-F.

IV. Results

While this paper is not a comparative evaluation of the different products the following overview of the sessions provides context, with highlights shown in Figure 1.

The first session (4 participants in Rec Room, see Figures 1a-1f) required an extensive set-up period (including instances of unboxing the headsets, creating accounts, and completing tutorials). Team members then began trying to locate one another in the virtual environment. Identity information was shared via the parallel video-conference call and invitations were issued in VR allowing everyone to join the same version of the foyer. After some informal interactions with strangers, the team moved into a new room to explore the authoring opportunities. This was also a private opportunity to discover the social affordances and features of the application, such as simulated touch, 3D sketching and shareable interactive objects. The team then moved to a game of paint-ball to evaluate possibilities of an established world and to investigate opportunities to engage and collaborate.

The second session (3 participants in VR Chat, see Figures 1g-1l) had two team members joining for the first time. This platform allows team members to congregate in the private space of one participant to collectively explore the facilities available for interaction, including the avatar customization options. The team elected to explore a range of the environments on offer encountering opportunities to use different forms of locomotion (tree climbing and portals), sketching tools and to interact with users from outside the team.

During the third session (4 participants in Altspace VR, see Figures 1m-1q) the team gathered in the home space of group member to gain confidence in the communication and interaction opportunities before exploring a selection of the public environments on offer. This included a joint attempt at using the world authoring tools, sharing video content in a movie theatre and interacting in a large public space with many more participants.

The final session (5 participants) covered a range of specialised platforms. The Oculus social tools are a potential coordination mechanism (see Figure 1r). BigScreen allowed the team to meet and interact, to use a limited set of drawing tools, and did allow sharing a view of a desktop computer (see Figure 1t). Epic Roller Coasters had only brief periods of connectivity (see Figure 1u). PokerStars VR demonstrated a range of sophisticated communication and interaction techniques but tightly constrained to playing a game of poker (see Figure 1v).

A. Thematic analysis

The transcriptions and reports, stripped of all supporting annotations, are subject to automatic thematic analysis using two methods: the AutoTag algorithm provided by the machine learning service Algorithmia[1], and a WordNet based topic extractor[2]. Both strategies use Latent Dirichlet Allocation (**LDA**) [17] which provide word distributions that characterize a block of text. AutoTag runs on the individual sentences in the documents, and returns sets of individual words as tags. The topic extractor builds topics from the entire corpus and returns topic vectors, truncated to top 5 word stems for each sentence. The most notable tags, scored based on number of occurrences, and the number of documents they occur in, are then presented to the team for further consideration, as shown in Table I. Section V describes the insights derived from the review sessions.

V. Discussion

A. Teaching environment organization and management

A common theme is control over the social construction of the experience. This includes the uncertainty of dealing with a complex new environment where the rules are mutable and not even consistent between applications. From a teaching perspective losing control of the teaching environment is a concern particularly where the teacher is assumed to be responsible for managing student behaviour or resolving technology issues [18]. Control issues occur when combining learning to use a new VR application with simultaneously coordinating with other participants.

[1]https://algorithmia.com/algorithms/nlp/AutoTag

[2]https://radimrehurek.com/gensim/auto_examples/tutorials/run_lda.html#sphx-glr-auto-examples-tutorials-run-lda-py

As freely available public applications, a number of the sessions involved interactions with random strangers; users outside the evaluation team. None of these experiences were deliberately malicious, but these interactions might violate behavioural standards for many educational institutions. Access controls need to be (pre)configured for each participating individual.

Virtual reality is a place where unrealistic things can happen, even when the application tries to provide a naturalistic interface. Mechanisms such as locomotion and interface interactions need to be mediated through controllers. There was no consistent mapping of controls across the different applications in this trial. Applications innovate in this respect, but this does limit the ease with which one application can be substituted with another. The 2 hours set aside for each session are close to the VR endurance limit for each participant.

B. Teaching environment suitability

Several tags relate to the tools and facilities provided that would support teaching activities. Applications support sketching in 3D space and writing on surfaces, typically using a whiteboard metaphor. Tools exist to support typical forms of social interaction (e.g. sending messages or inviting others to join in activities). Content sharing and importing prepared materials from external applications is required when preparing teaching materials. Some applications, such as BigScreen, allow access to particular external media (such as YouTube videos) and even allow desktop sharing. Any content developed specifically for a particular VR application may need to be transferred to other applications or exported in ways that allow it to be presented elsewhere. Teachers already have non-VR solutions that can share and present 2D content effectively.

C. Environment representation, manipulation and authoring

The spaces visited are variously referred to as environments, spaces, rooms and worlds. The rooms also serve to describe location in an otherwise unaddressable space, particularly when providing to routing information to others. Despite the use of locomotion metaphors, transitions between rooms is magical with no sense of direction or distance covered.

Use of walled rooms is typical for a teaching setting. Several applications include private space(s) which extend the concept of personal space to represent the portion of a world where an individual feels in control of the environment. Customization of the environment is supported for private spaces and with some opportunities to adapt public spaces for a short period of time. Authoring facilities explored include: drawing on surfaces such as whiteboards, sketching shapes in 3D, placing static furnishing, utilizing shared interactive objects (such as popcorn containers), visiting worlds authored by other users (external to the team) to identify customization opportunities, placing doors and portals to provide pathways, and sharing external content (video and desktop applications).

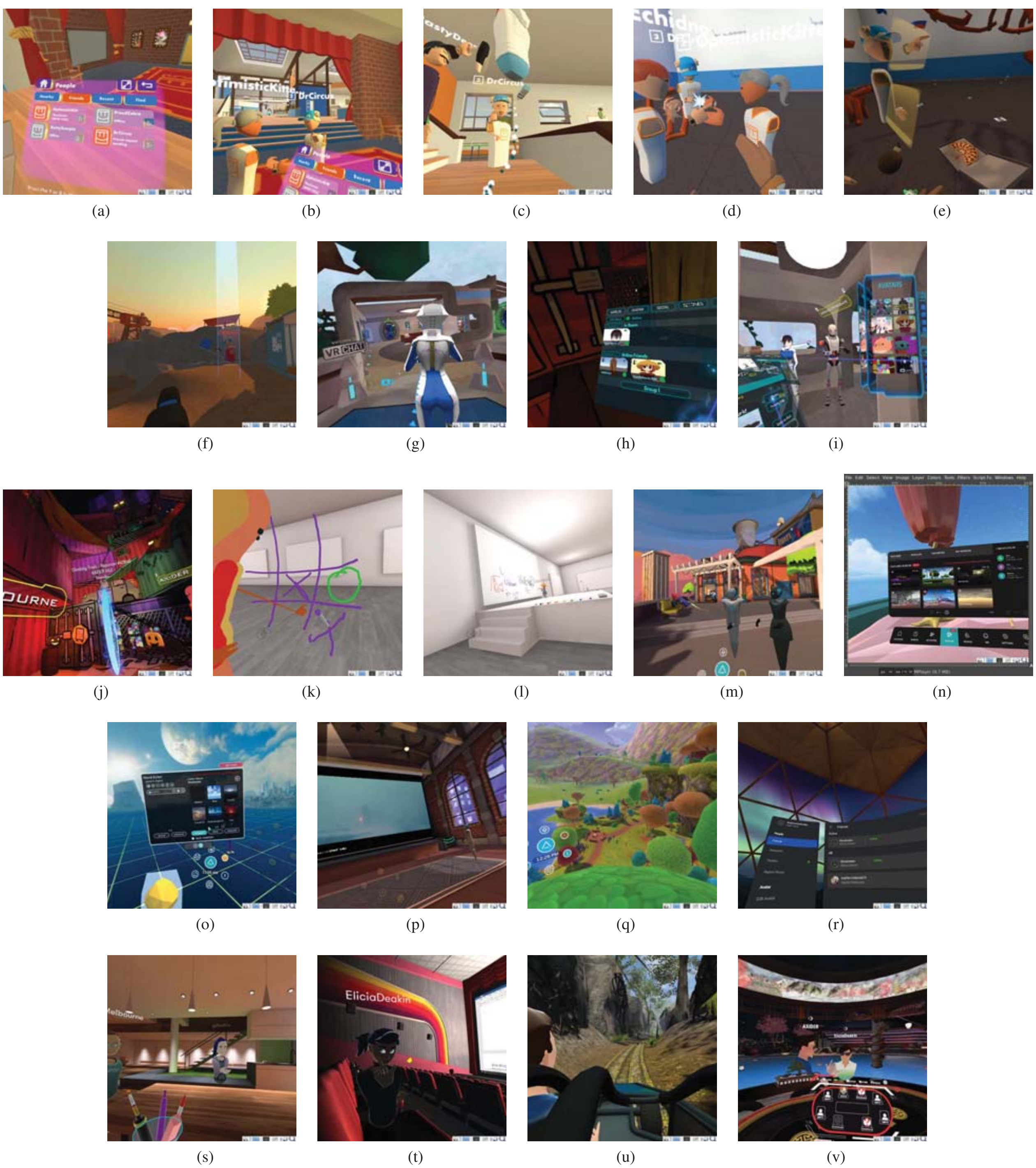

Figure 1: Highlights of the evaluation sessions. (a) Rec Room: Sharing identities and status within the team (b) Rec Room: Team assembling in shared room (c) Rec Room: random strangers sharing water. (d) Rec Room: Team in private space touching virtual hands (e) Rec Room: Aftermath of using sculpting and furnishing facilities (f) Rec Room: Paintball exploring locomotion and team coordination (g) VR Chat: Home space (h) VR Chat: Inviting team members to your world (i) VR Chat: Customizing avatars (j) VR Chat: Creating portals to guide team between worlds (k) VR Chat: Adapting drawing tools for a spontaneous activity (l) VR Chat: Tools supporting a traditional teaching context (m) Altspace: Team meeting in home space (n) Altspace: World selection and friend status display (o) Altspace: Group world authoring (p) Altspace: Jointly viewing content imported from external sources (q) Altspace: Large public virtual environment (r) Oculus: Team coordination using the Oculus Parties facility (s) BigScreen: Meeting around a table (t) BigScreen: Desktop sharing (u) Epic Roller Coaster: Brief period of connectivity on a joint roller coaster ride (v) PokerStars VR: The team assembled around the poker table.

Topic Extractor		AutoTag	
Topic	Score	Tag	Score
0.031*"student" + 0.018*"need" + 0.014*"specif" + 0.013*"environ" + 0.012*"control"	14.1	yeah	0.635
0.050*"yeah" + 0.031*"like" + 0.020*"think" + 0.017*"go" + 0.016*"room"	11.0	room	0.531
0.076*"yeah" + 0.023*"like" + 0.022*"right" + 0.020*"think" + 0.016*"go"	8.06	user	0.407
0.028*"room" + 0.020*"interact" + 0.017*"tool" + 0.016*"group" + 0.015*"avatar"	7.37	students	0.396
0.033*"content" + 0.029*"bigscreen" + 0.023*"share" + 0.022*"rollercoast" + 0.019*"applic"	7.35	teaching	0.313
0.040*"bigscreen" + 0.027*"poker" + 0.018*"control" + 0.018*"room" + 0.017*"access"	6.50	space	0.308
0.049*"yeah" + 0.035*"think" + 0.027*"like" + 0.013*"app" + 0.011*"thing"	6.35	content	0.288
0.036*"world" + 0.025*"altspacevr" + 0.022*"student" + 0.022*"interact" + 0.019*"experi"	5.49	control	0.288
0.050*"yeah" + 0.020*"like" + 0.018*"right" + 0.018*"room" + 0.017*"good"	3.37	screen	0.268
0.040*"draw" + 0.030*"button" + 0.022*"special" + 0.020*"unfriend" + 0.018*"brush"	3.17	session	0.261

Table I: Top ten themes identified by the two automated analysis strategies.

D. Identity and representation

A significant part of many applications is personalization of avatars which is reflected in time spent during the sessions. Presenting a particular identity is a significant part of interacting through a synthetic reality [11]. Despite the team having established prior inter-personal relationships, it takes time to learn to associate the visible avatars and their in-application identities with each individual. This is likely to affect how students interact only with their peers and teachers when only knowing them through their avatars.

E. Troubleshooting and establishing communication

Establishing personal connections in the virtual environment was a significant issue. The main challenge was getting everyone in the same place at the same time. The parallel video conference call was vital in coordination particularly for participants still in the process of signing up, logging in, completing training tutorials, customizing settings, sharing the account identity with friends and colleagues, or experiencing equipment issues (such as recharging or replacing batteries).

Many applications use separate copies of the lobby worlds so that participants appear to be in the same world but are really in a different version. A group member needs to be the designated anchor who then invites others to the session. Teachers trying to run a class would need to designate someone to handle this.

F. Recommendations for virtual reality teaching environments in higher education

Presentation environments encountered in this study depict traditional classrooms with single teacher as the focus, positioned near to a presentation or whiteboard. Innovating teaching in these settings focuses on the ‘tricks’ possible in VR, rather than what would add value to the learning experience. Other forms of learning are already possible: around groups forming on demand, the freedom to draw in content as needed, or to improvise using the tools available. Historical notions around control of behaviour, the environment and the technology evaporate, and with it the responsibility of the teacher to ensure learning. We recommend continuing to expand on changing perceptions and removing unnecessary physical constraints. Flexible VR teaching applications need to consider: content import, content sharing, authoring facilities, social interactions, control over exposure to external influences such as people outside the class, and persistence for contributions made to world by participants.

Based on our experience we frame the hypothesis: discovery in an unfamiliar environment yields better cooperation to support learning than following the narrative of a defined lesson plan. Mental models, concepts and terminology need to evolve along with the use of virtual reality. Describing how to find a location or resource, or identifying a particular manifestation of an individual, are new ideas to be absorbed at the same time as any teaching on these platforms. Existing representations of self become mutable in the virtual world, as do the roles associated with participants in a teaching context. There are opportunities to adapt how identity is expressed, and to include it as part of the learning process with personalized avatars likely to be embraced by students and teachers alike.

Participants need to have a strategy to deal with getting lost. Default authoring tools cannot be easily repurposed to support ad hoc or spontaneous teaching activities.

G. Strengths and weaknesses of this study

This study is an exploratory investigation of opportunities, rather than a comparative product review or user experience evaluation. The focus is instead on usability and usefulness for a purpose for which they are not originally designed: as versatile teaching platforms.

All of the study participants have worked with VR for several years and are familiar with the design, technical, and educational considerations involved in such platforms, representing an expert evaluation panel. Preferences for particular focus topics exist through the specific interests of each member of the team. The steps followed ensure that this study is more than a collection of personal anecdotes and that the insights do relate to observed phenomena.

The study employs automatic transcription and thematic analysis which possibly introduces transcription errors and lack of direct semantic review. The important tags and topics are reviewed by the team and validated against the source materials. The results serve to identify requirements for bespoke educational VR platforms, and to identify topics for more focused research.

VI. Conclusions

This is a pilot study to identify practical issues affecting re-purposing of existing VR platforms as teaching environments. The experiment provides insights into what would happen when transitioning to learning and teaching within VR. In conclusion the team still believe that teaching activities could be embedded within a virtual reality application, particularly where third party content could be easily imported and utilized. Collaborative evaluation of these platforms reveals social interactions on these platforms that would not be possible in an isolated review.

A shared virtual world provides opportunities to engage as individuals using a chosen identity. While none of the applications tested are specifically intended for teaching, this study offers insight into design requirements without the overhead of building bespoke applications.

A. Future work

This study suggests specific features required, particularly authoring opportunities and dynamic content creation tools that could be employed during a class. The insights identified priority features required for developing bespoke solutions; both general teaching platforms and context specific training opportunities. Since this study was conducted we have started trialling particular applications for our classes, and into utilizing applications that work across multiple platforms.

References

[1] D. Kaminska, T. Sapinski, S. Wiak, T. Tikk, R. Haamer, E. Avots, A. Helmi, C. Ozcinar, and G. Anbarjafari, "Virtual reality and its applications in education: Survey," *Information*, vol. 10, no. 10, p. 318, 2019.

[2] J. Riman, N. Winters, J. Zelenak, I. Yucel, and J. G. Tromp, *Emerging Extended Reality Technologies For Industry 4.0*. John Wiley & Sons, Ltd, 2020, ch. Mixed Reality Use In Higher Education, pp. 3–16.

[3] K. Stepan, J. Zeiger, S. Hanchuk, A. Del Signore, R. Shrivastava, S. Govindaraj, and A. Iloreta, "Immersive virtual reality as a teaching tool for neuroanatomy," *International Forum of Allergy & Rhinology*, vol. 7, no. 10, pp. 1006–1013, 2017.

[4] S. Perry, M. F. Burrow, W. K. Leung, and S. M. Bridges, "Simulation and curriculum design: a global survey in dental education," *Australian Dental Journal*, vol. 62, no. 4, pp. 453–463, 2017.

[5] L. Shackelford, W. D. Huang, A. Craig, C. Merrill, and D. Chen, "Relationships between motivational support and game features in a game-based virtual reality learning environment for teaching introductory archaeology," *Educational Media International*, vol. 56, no. 3, pp. 183–200, 2019.

[6] K. Schrier, *Learning, Education & Games, Volume 3: 100 Games to Use in the Classroom & Beyond*, ser. Learning, Education and Games. Lulu.com, 2019.

[7] J. Garcia Fernandez and L. Medeiros, "Cultural heritage and communication through simulation videogames – a validation of minecraft," *Heritage*, vol. 2, pp. 2262–2274, 2019.

[8] M. Dezuanni and J. O'Mara, *Serious play: Literacy, learning and digital games (Digital Games and Learning):*. United States of America: Routledge, 2017, ch. Impassioned learning and Minecraft, pp. 36–48.

[9] G. C. Nunez-Mir, B. V. Iannone III, B. C. Pijanowski, N. Kong, and S. Fei, "Automated content analysis: addressing the big literature challenge in ecology and evolution," *Methods in Ecology and Evolution*, vol. 7, no. 11, pp. 1262–1272, 2016.

[10] G. Cooper, H. Park, Z. Nasr, L. P. Thong, and R. Johnson, "Using virtual reality in the classroom: preservice teachers' perceptions of its use as a teaching and learning tool," *Educational Media International*, vol. 56, no. 1, pp. 1–13, 2019.

[11] C. Fowler, "Virtual reality and learning: Where is the pedagogy?" *British Journal of Educational Technology*, vol. 46, no. 2, pp. 412–422, 2015.

[12] N. Rodriguez, "Teaching virtual reality with affordable technologies," in *Human-Computer Interaction. Theory, Design, Development and Practice*, M. Kurosu, Ed., vol. 9731. Cham: Springer, 2016, pp. 89–97.

[13] X. Shao, Q. Yuan, D. Qian, Z. Ye, G. Chen, K. le Zhuang, X. Jiang, Y. Jin, and D. Qiang, "Virtual reality technology for teaching neurosurgery of skull base tumor," *BMC Medical Education*, vol. 20, no. 1, p. 3, 2020.

[14] H. Elkoubaiti and R. Mrabet, "A survey of pedagogical affordances of augmented and virtual realities technologies in lot – based classroom," in *2018 IEEE 5th International Congress on Information Science and Technology (CiSt)*, 2018, pp. 334–341.

[15] L. Coyne, J. K. Takemoto, B. L. Parmentier, T. Merritt, and R. A. Sharpton, "Exploring virtual reality as a platform for distance team-based learning," *Currents in Pharmacy Teaching and Learning*, vol. 10, no. 10, pp. 1384–1390, 2018.

[16] J. Tsigarides, J. Curl-Roper, S. Holland, and V. Rodrigues, "Tr5 the sim360 trial: innovating simulation training with the use of a ''flipped'' 360-degree virtual reality video. a feasibility rct," *BMJ Simulation and Technology Enhanced Learning*, vol. 4, no. Suppl 2, pp. A39–A39, 2018.

[17] D. M. Blei, A. Y. Ng, and M. I. Jordan, "Latent dirichlet allocation," *J. Mach. Learn. Res.*, vol. 3, no. Jan, pp. 993–1022, 2003.

[18] S. McKenzie, R. Hains-Wesson, S. Bangay, and G. Bowtell, "A team-teaching approach for blended learning: an experiment," *Studies in Higher Education*, pp. 1–15, 2020.