OPPORTUNITIES AND CHALLENGES FOR VR-MEDIATED EDUCATIONAL RESOURCES: AN EDUCATORS' PERSPECTIVE

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Abstract

With the increasing expectation on educators to make innovative use of technology within the classroom, how these technological platforms and tools are populated with educational resources is important. Many platforms require specific training including immersive technologies such as Virtual Reality (VR). To realize the benefits of VR, it is important to understand barriers facing the adoption of this technology, least not how educators use or want to use this technology.

This study, through surveys and interviews with practicing educators, aims to understand the challenges of educational resource creation and its relation to the wider adoption of VR technologies within education. It is positioned as exploratory in nature, the results determining the potential scope for further investigations

We found that time pressures on educators was major barrier and that a large portion do not create resources in collaboration with their peers. However, they do demonstrate a willingness to use enhanced productivity tools and online tools. Nearly half of respondents stated they do not use external repositories to source resources. This indicates that despite many repositories of resources existing, it is difficult to find resources or that the resources do not match educators' requirements.

For VR adoption within education, we found the overwhelming majority are receptive and identified interesting and unique ways in using this technology (thought exercises, mind mapping etc.). Interview responses showed a relation between how VR can be used (unable to conceptualize teaching activities for use in VR) and how difficult or time consuming it would be to populate VR environments with the required teaching/learning resources.

This survey should help designers of VR-based tools, content or resources to understand the challenges faced by educators and make informed decisions about the capabilities desired by them.

We recommend education leaders to be mindful of the challenges associated with time and skill required to use VR. We also suggest that in order to enhance adoption, education VR application developers create curated repositories of educational resources and provide tools that let teachers trivially create additional resources for these applications.

Keywords: Virtual Reality, Resource Creation, Innovative Technologies

1 INTRODUCTION

The education sector has significantly changed over the past two decades. Most of these changes are associated with the use of the Internet and associated applications and devices in the classroom, such as smart phones, tablets and modern computers. As these technologies continue to evolve, they become more pervasive and influential in our lives, bridging the gap between workplaces, education and the home. The Internet of Things (IoT), Robotics, Artificial Intelligence (AI), Virtual Reality (VR) and Augmented Reality (AR) constitute the bulk of the latest advances. As more educational institutions adapt to these emergent technologies, some have struggled to acquire the skills and knowledge to enable them to update their existing educational practices. This difficulty can be split into two main factors. The first issue is structural and is attributed to the to the inability of institutions to fund the digital investment necessary to acquire new hardware and software technologies. Institutions are also resistant to retire existing hardware and software, which they may consider perfectly serviceable, to make way for new technology. The second issue considers educators' inability to conceptualise how new technology might be used in their practice and how to modify existing resources and apply the new technology in meeting the ever-changing requirements of students.

Resource creation is a time-consuming task, and it is not always immediately obvious how to populate these platforms with the high-quality resources that both institutions and students have come to expect. Many platforms require specific training, and this has become even more apparent with the advent of

immersive technologies such as VR and AR. The key to using these technologies effectively is high quality educational content that leverages all the benefits that these technologies offer, for which we need to identify the tools required by educators to do this.

This study, through surveys and interviews with practicing educators, aims to understand the challenges of educational resource creation and its relation to the wider adoption of VR technologies within education. As the first study investigating this combination of resource creation and VR, it is positioned as exploratory in nature, with the results determining the potential scope for further investigations.

2 BACKGROUND

As our study investigates the barriers educators face in adopting VR within their practice, specifically factors relating to resource creation, it builds upon existing literature not only with the VR domain, but also within the wider technology enhanced learning (TEL) space. Considering why technology is important for education, and the advantages VR affords, is crucial to identifying and understanding these barriers.

2.1 Technology Enhanced Learning

Three terms are used interchangeably throughout the literature to describe the process of using technology within education - eLearning, blended learning and TEL. eLearning generally refers to the platform, typically customized institution-based platforms such as Moodle or Massive Open Online Courses (MOOCs). Blended learning is the pedagogy – i.e., how the module or course is built (including flipped learning). TEL appears to be the prevalent term in referring to the whole overarching concept [1], [2] of using technology within teaching.

TEL has been transformative in the education sector. A meta-analysis [3] of over one thousand studies found that students performed better in conditions that were a blend of face-to-face learning and online learning versus students that experienced face to face teaching only. TEL has the capacity to improve the student experience and promote collaborative behaviors [4], [5]. It has been praised for enhancing the teaching of traditional subjects and in exposing and preparing students for the modern technology centered workplace [6]. However, there are still significant barriers to its adoption and effective use by educators. Identifying the barriers educators face in deploying and using these TEL platforms is critical to widening their use.

2.2 VR Within Education

A technology that is growing in the education sector is VR. VR can be defined as "*a medium composed of interactive computer simulations that sense the participant's position and actions and replace or augment the feedback to one or more senses, giving the feeling of being mentally immersed or present in the simulation (a virtual world)*" [7]. The adoption of VR has been examined in most fields, including applications related to tourism [8]–[10], gaming [11], firefighting [12], the legal profession [13] and construction management [14]. Over the last 20 years, VR has seen a rapid advancement in both technology and application development. The miniaturization of components has also seen the need for headsets being tethered to a PC.

Students engagement in the learning process has the potential to be significantly enhanced by VR [15], [16]. By allowing users to interact with objects within a 3D space, VR offers pseudo-physical interactions [17] that contributes to a sense of presence in the virtual world, increasing engagement. With past low-cost devices such as the Oculus Go, haptic feedback and true six degrees of freedom (DoF) movement were not possible. However, with the advent of the Meta Quest 2, this is now available at an entry level price point. These entry level devices extend the use case scenario of VR in education, with the potential for VR being included in an institutions flipped learning strategy [18], allowing students to learn key concepts away from the classroom.

A direct and well understood benefit of VR in education is the capacity for it to motivate learning within students. Although initially considered to be a novelty effect, studies [19] have demonstrated this not to be the case. Bogicevic et al. [8] concluded that VR "*induces higher elaboration of mental imagery about the experience and a stronger sense of presence*". Medical procedures, including intubation and laparoscopy, along with eye surgery are areas showing strong development of using VR in training [20], [21]. The impact of VR applications has been evaluated on students' performance in the engineering discipline with positive results recorded among a group of 48 students [22]. The option of VR being used

as a content delivery platform for class material has been explored in a business class, whereby students rated their enjoyment and interest to be higher, increasing their engagement in learning activities [23]. Community learning via VR is also an active field of research. In Wako, Japan, citizens utilized VR to experience an immersive model of a supernova [24].

2.3 Barriers to Adoption

The slow adoption of VR technologies within education has little do with its effectiveness from a student perspective [25]. Most of the barriers VR faces in its adoption within education is shared by all new technology, so it is useful to review the wider literature surrounding technology adoption.

While most research for using technology in education centers on students attitudes [26]–[28], including Human-Computer Interaction (HCI) centered research [29]–[31], there is some previous research that looks at the factors and issues [32]–[36] from an educators perspective. In a wide ranging review of these factors within an higher education setting, Senik and Broad [33] identify several key factors that provide barriers to technology adoption. These are primarily lack of interest; resistance to innovation; demands on faculty time; unacceptable learning methods to students; limited knowledge of technology; preference for traditional teaching methods; reluctance to change teaching approach; problems with technology itself; lack of resources; lack of intuitional support; lack of technical support [37], [38]; and, a culture of change resistance. Sangster [39] also identifies the unwillingness of some educators to experiment as a barrier which thus affects their desire to use technology in their practice. Roberts et al. [40] categorizes these barriers into three distinct areas. The first is social, i.e., professional network, peers' conformity and attitudes. The second is organizational, i.e., institutional support and infrastructure, training, and funding. The last is individual, i.e., willingness to change, learning new skills, and ability to operate out of their comfort zone. Gregory and Lodge [41] also highlight academic workload as a barrier.

While the above barriers are well described in the literature, there is a distinct lack of consideration on how educators populate new technology with educational resources. There is an assumption that educators will simply transfer over and adapt or modify existing resources. However, with the advent of technology such as VR and AR, there are specific challenges involved in this. A VR world is typically created in a 3D modelling program combined with a software development environment such as Unity or Unreal. The skills and knowledge to do this are generally beyond those which most educators possess. Therefore, not only is it important to understand how educators currently create and use resources, but we also need to anticipate how they might want to use these resources for new technology such as VR. This is the research gap that this paper attempts to address.

3 METHODOLOGY

The aim of this study was to explore the factors which affect VR adoption by educators, particularly those factors relating to resource creation. We focus predominantly on educators' perception of VR utility, rather than benefits to students since this is well covered in previous research. Due to identifying a gap in the literature, our primary concern is the creation, re-use and modification of educational resources for VR activities. By way of surveys and semi-structured interviews, we sought opinions and attitudes towards these factors while also collecting information on what kind of activities educators would use VR for. As an exploratory study into a new area, this research is intended to provide a baseline understanding of the issues facing educators for these specific factors, thus informing future research and design of VR educational applications and platforms.

3.1 Participants

Interview volunteers were pre-screened so that only those educators who actively use technology in their teaching were selected as participants. From these, five interview participants were selected, representing primary, secondary, FE and HE education within the UK.

A Qualtrics survey was distributed among education networks (Discord and the researchers pre-existing network) to ensure that only those with teaching responsibilities completed the survey. Completion of the survey entitled the participant to be entered into a raffle for a £20 Amazon gift voucher.

3.2 Demographics

35 respondents identified as male, 25 female and one preferred not to say. 31 respondents taught at primary level, 13 at secondary, 7 at FE (Further Education), 8 at HE (Higher Education) and 7 in a non-academic setting (i.e., workplace training). The cumulative total is higher than 61 as some taught at multiple levels (i.e., FE+HE). Geographically, 28 respondents were from the UK, 4 from Europe (not including UK), 23 from North America, 3 from Central America and 3 from South America. 56 respondents held a formal teaching qualification, 5 did not. We only asked those from the UK what kind of teaching qualification they held. Degree with QTS (Qualified Teacher Status) was the most frequent with 11, 4 each for PGCE in post compulsory (age 14+) and Fellowship of the Higher Education academy, and 3 for PGCE (Post Graduate Certificate in Education) with QTS. 50 respondents stated they taught full time with the remainder part time. 46 respondents stated they had some management responsibilities and 15 that they did not. Of those with management responsibilities, 23 were a subject lead and 13 department lead and the remainder spread across the remaining categories at 2 (+/-2). Subjects taught among respondents were English, Art (including music, fashion etc.) and Computer Science at 8 respondents each, 5 for mathematics, 4 for Foreign Languages and Geography, 3 for Science (Physics, Chemistry and Biology) with the remainder spread across the other subjects.

3.3 Interview Strategy

Participants were interviewed in a semi-structured manner, using the survey as a guideline for questions. Interview participants were guided through the survey so that comparable demographic data could be collected among the survey respondents and interviewees. Where responses mandated an open-ended answer, these were given verbally to the interviewee and the interviewer elicited further responses where required. This allowed for more verbose and in-depth survey responses, illustrated by the average survey response time of 20 minutes versus 45 minutes for the interviews. All interviews were audio recorded with permission from the participants. All interviews were conducted in English.

3.4 Analysis

Statistical analysis was conducted through a combination of Qualtrics own inbuilt analysis tools, Excel and IBM SPSS 26.

Interview recordings were auto transcribed using Otter.ai then manually checked and refined for accuracy. 213 quotes were identified during initial coding of the transcribed interviews with 31 themes identified via a deductive approach. For the themes, these were further analyzed using inductive thematic analysis [43], resulting in 5 major themes identified. To ensure reliability, the primary researcher conducted analysis in concert with two additional researchers unrelated to the research and no involvement with conducting the interviews or initial transcription. The primary researcher's native language was English as was one of the additional researchers, with the remaining researcher having Dutch as a primary language but with a high level on English fluency. For each theme, each researcher initially clustered one third of the quotes. The researchers then discussed each cluster until consensus was reached upon the correct make up of each cluster which were then finalized for further analysis and from which the results of the study could be derived. Additional analysis of the survey responses was carried out by the researchers, following a similar thematic analysis that was used to validate and triangulate the interview quotes and arising themes.

4 RESULTS

Initially, 74 survey responses were recorded. After data cleansing on the completed surveys, we had 61 valid surveys to analyze. Data cleansing included removing all surveys completed faster than 7 minutes, accounting for random click through just so the participant could be entered into the raffle, and removing survey responses that contained nonsense responses to important questions (i.e., survey questions VR1, VR2, VR4 and VR6) for the same reason.

4.1 Resource Creation

Respondents were asked how many hours they were allocated for resource creation (from scratch). The mean response was 6.46 hours (σ4.59). Next, respondents were asked how many hours they actually spent creating resources (from scratch) including in their own time. The mean response was 8.87 hours

(σ4.81), indicating a significant 25% increase over the actual allocated time. One interviewee commented "*it's annoyingly high*".

The most common types of resources being created by the respondents were lesson plans (30), Slideshows/Presentations (29), worksheets (20), syllabus (20), tutorials/'how to' guides/instruction manuals (19), online quizzes (18), online learning pages – i.e., Moodle etc. (17) and illustrations/diagrams (16).

45 respondents stated they regularly created resources in collaboration with other educators, 16 did not. For those who did create resources in collaboration with other educators, 17 did so more than once a week, 12 once every two weeks and 9 once a month. Reasons given for collaborating were given as "*other colleagues will often share a good resource*" and "*to support each other*". For those who do not create resources with other educators, the main reasons given (respondents could select more than one reason) were planning time does not synchronize with colleagues (14), not enough time (10) and not required to (8).

Respondents were asked how many hours they spent sourcing resources from within their organization. The mean response was 4.89 hours (σ3.53). They were asked to name some of the resources they might source. These mainly included re-usable but generic resources such as schemes of work, lesson plans and syllabuses.

Respondents were asked if they sourced resources from external providers. 36 responded they did and 25 responded they did not. Respondents stated they spent 3.92 hours per week sourcing these resources (σ3.49). Respondents were asked where they sourced external resources from. The responses were varied but coalesced around mainstream providers such as TES.co.uk (originally the Times Educational Supplement), EEF (Education Endowment Foundation) and White Rose. 25 of those who sourced external resources stated they modify them in some way and 11 did not. Most respondents stated they only modified the resource in minor ways.

Next respondents were asked what are 3 of the typical tools they use to create resources from scratch. 16 respondents mainly used standard productivity tools (Office), of which Word (11) and PowerPoint (7) were the most common. 11 used a mix of standard productivity, enhanced productivity (Adobe Suite etc.) and online tools (Google docs, Kahoot quizzes etc.). 5 mainly used online tools and 3 mainly used enhanced productivity tools.

4.2 Virtual Reality

In measuring respondents' attitudes to VR adoption, we utilized Plutchik's emotion wheel [42], [43]. We coded each response with positive or negative value, radiating from plus or minus 3 from the inner wheel to 1 on the outer wheel (i.e., rage would be -3 and serenity would be 3, see fig. 1). The average Plutchik coded score was 2.25 (σ-2.78), indicating a largely positive emotional response to VR being introduced

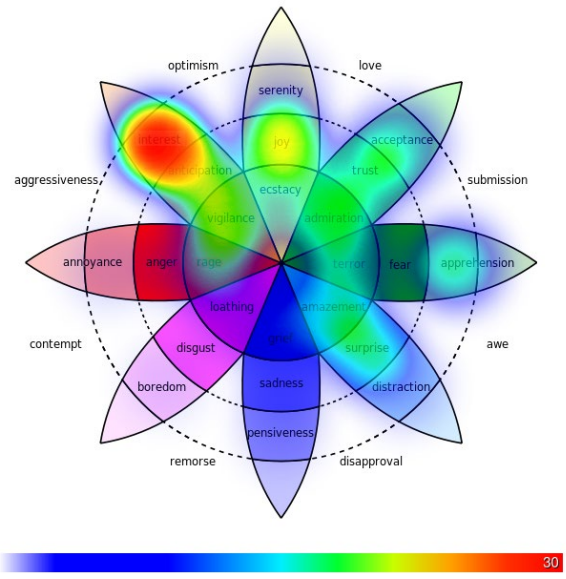

Figure 1 Plutchik responses when asked to select their top three feelings when being asked to teach with VR

in their practice. Interest (30), joy (16) and anticipation (14) were all significant responses with apprehension (13) being the most common negative response. The results can be seen in fig 1.

Respondents were also asked what type of educational benefits they thought VR would provide. The responses were wide ranging and difficult to categorize however respondents did recognize VR as immersive and VR activities being fun and stimulating. They highlighted VR being able to provide the opportunity to experience environments not accessible normally, such as space and important world places.

We asked respondents what kind of educational activities they would use VR for in their practice (could choose multiple). Simulations was the overwhelming response (35) with the remainder being quite varied. Games and co-operative games were a common response (21 and 20 respectively). Thought exercises such as brain storming (18), mind-mapping (15) and concept-mapping (14) were also popular responses. The results can be seen in fig 2.

4.3 Themes

Five main themes recurred across most participants.

4.3.1 Repositories of resources

Only one main theme emerged with respect to creating resources generally. Well curated repositories of good quality education resources were not only desired but also the preferred method of acquiring resources over creating their own. Statements like "*some kind of repository of common resources*", "*there have been some productions that have been recorded using for VR ~ but is that ~ readily available*" were common.

4.3.2 How is it better for students or what is the educational benefit?

Interviewees felt that VR providers (i.e., application developers and hardware vendors) did a poor job of conveying the benefits of VR for students. It was felt this harmed the potential for VR to be adopted with responses such as "*concerns from a teaching perspective would be ensuring that it was actually benefiting the student experience*", "*how does everything get incorporated together so that VR is, is a supplement that makes a lesson better collectively*", "*what would be the benefits to the student*". Inclusivity also appeared to be a concern with some responses such as "*or is only benefiting for certain students*". Respondents indicated they would like to see evidence-based research to justify using new technologies such as VR.

4.3.3 Classroom Management

Another barrier to adoption that respondents identified was behavior and/or classroom management aspects of using VR emerging from the challenge of managing both the physical classroom space and the VR learning space. Comments included "*I'd be concerned about behaviour*", "*if you try it, but then it*

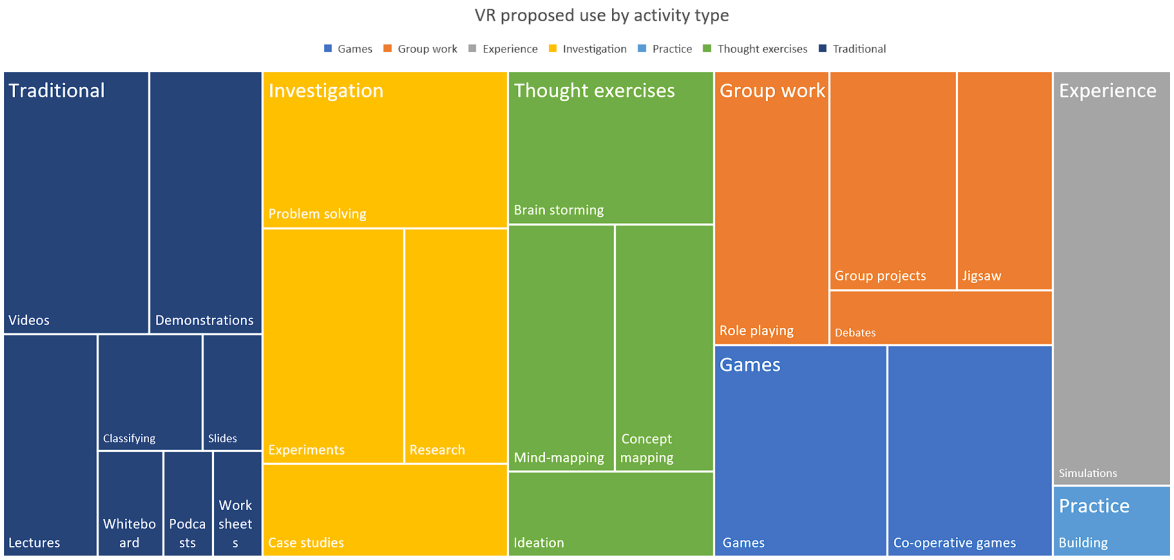

Figure 2 Respondents were asked what type of educational activities they would use VR for.

creates some behavioural problems that we couldn't deal with", "*I think behaviour as well*". Some thought it would be wise to see additional research on managing behavior for VR use and having institutional behavior policies updated to reflect the new technology.

4.3.4 Conceptualization of VR resources

Interviewees struggled to convey how they would create educational resources for VR. They could not conceive an appropriate process to do so ("*we haven't really described process because we can't conceive one*", "*I wouldn't know how to create a virtual world from scratch ~ I'd be really challenged on that*", "*I don't think there's any tools that I currently use that would translate"*). Interviewees also put forward that having access to existing resources would also give them inspiration on what to use VR for in their practice ("*I think maybe if maybe if I, if I use VR a bit more, then I might have an idea of how or why or at least what resources would be appropriate for it*",).

4.3.5 Multi-modal learning

Multi-modal learning was frequently discussed by the interviewees. Responses such as *"you can deal with all the students senses*" were common statements when considering the advantages of VR in education. One interviewee saw advantages in VR as in "*it gets students out of the ~ four walls of the classroom*". An interesting facet often discussed was the use of physical proxies in place of generalized VR controllers, such as musical instruments ("*kids just loved the idea of being able to see and be able to play these instruments and stuff*") or stage props ("*So you've got a virtual stage, and you can, you know, set people up in the right places even things like more technical stuff, like light control and stuff like that*"). However, interviewees also identified their institutions own policies presenting as barriers themselves when introducing new technology that enhances or promotes multi-modal teaching. For example, interviewees discussed blanket bans on mobile phone use ("*Massively against mobile phones being available*") despite recognized examples of their use being beneficial, and there was concern VR would be similarly treated.

5 DISCUSSION

An obvious discussion point is that educators spend more time creating resources than the time they are allocated, with the mean almost 9 hours a week spent on resource creation. This is nearly a quarter of a regular 42 hour working week. It is disappointing that despite attempts in the sector to reduce teacher workload these types of issues persist.

36 respondents (59%) stated they sourced resources from external organisations. This indicates that despite many repositories of resources existing, it is difficult to find resources or that the resources do not match educators' requirements. This has an obvious impact of increasing the time educators spend on creating their own resources from scratch. This was corroborated by the responses provided when asked what sources they use with only TES appearing in significant numbers, again indicating there doesn't appear to be a universal central repository of resources for educators that is frequently used. This has repercussions when considering the consistency of resources used across education.

It was encouraging to observe the overwhelmingly positive Plutchik responses to VR being introduced in the respondent's educational practice, indicating that educators are excited and open to the possibilities VR can bring to education. There were a small number of negative responses, however most of the negative emotions can be addressed, as illustrated through the interview responses that mention training, management support and comprehensive reasoning of how VR might benefit students and education. Furthermore, the slight negative Plutchik responses seem also in part related to behavior and classroom management concerns. Designers of VR applications need to think carefully about how educators need to manage both the physical and virtual learning spaces simultaneously. One possible solution would be to consider an Augmented Reality based "window into the world". This is an area ripe for future research.

The wide range of activities that educators stated they would use VR for is encouraging. It demonstrates, especially when combined with the emotional response to its introduction, a willingness to adopt the technology. While simulation activities might be an obvious and expected use case for VR, thought exercises was an unexpected outcome. While simulations tend to be domain specific, such as medical simulation etc., thought exercises tend to be domain agnostic and can cover a wider area of curriculum. Indeed, research into mind-mapping in VR is already ongoing [44] and it is encouraging that educators can see the potential for VR in this area. As pedagogy continues to move away from the once fashionable VARK model [45], where it was once thought that students had one preferred learning style,

educators have come to realize that multi-modal delivery is best placed to leverage these learning styles [46]. As illustrated in the interview responses, this is also demonstrated by our participants whom frequently posited that VR was a potential tool to support this multi-modal approach.

The final point to address in this study is how respondents struggled to conceive how they would populate VR worlds with appropriate educational resources. Current state of art VR development is generally not fit for purpose to be used directly by educators given the amount of specialist knowledge needed to build basic content. The time required is proportional to how complex the development tools are for content creation. Critics may argue that bespoke applications may be the solution, but they are a stop gap for more generalizable, topic agnostic environments. Bespoke applications do not allow customizations that allow educators to leverage VR for a wider range of topics and encompass true multi-modal teaching.

6 CONCLUSION

Through this exploratory study we identify educators are excited about the benefits that VR can bring to education and students, although they need to be better informed about the tangible benefits on offer. Similarly, they have wide ranging ideas for what activities VR can be used for, but they are concerned about the time, skill and tool requirements to create and populate VR worlds with educational resources.

We recommend education leaders not to underestimate the time or skill required to use VR in the classroom. Additionally, we suggest education VR application developers look at creating the domain agnostic applications desired by educators. They should also relieve the pressure on teachers by creating wide ranging repositories of educational resources and ensure tools exist that let teachers trivially create additional resources for these applications. Concurrently, institutions should invest properly explaining the educational benefits of VR generally and specifically how it relates to students learning. They should also consider how new technology affects their behaviour management policies and adapt or provide updated guidance accordingly. Education leaders should bear these recommendations in mind when procuring and deploying VR in their learning environments so that they may select the best solutions available.

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