Why the Educational Metaverse is not all about Virtual Reality Apps

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Abstract. This paper explores how the Metaverse can be used in the context of learning and collaboration. In it we seek to dispel the story that the Metaverse is just another synonym for Virtual Reality and future technology. Instead we will argue that the Metaverse is another interface scaffolding story akin to an interaction metaphor and can be used in an analogous manner to that of the Desktop Metaphor. How it is rendered in reality is a very flexible implementation detail. Instead, it should be thought of as a conceptual space and as an information sharing channel. As long as you are engaging in the Metaverse conceptually you can be there practically and in reality. As such it can be a low bandwidth and/or a high bandwidth information superhighway, depending on the specific mode of interaction. The use of metaphor and sharing has been with us a long time in learning technology and shared/collaborative interaction. So it is wrong to put down the aims and objectives of the Metaverse for Education as just an exercise in expensive high bandwidth Virtual Reality. It is not something that is based on technology for technology's sake. It clearly has a role for those with access to advanced technologies, bandwidth, and hardware. In this paper we will however argue that this limited view fails to understand the possibilities it opens up for those who do not have such facilities available. Instead the Metaverse provides learning and collaboration possibilities for the many, not the privileged few.

Keywords: Collaborative Learning in Online Environments/ CSCL, Human-Computer Interfaces and Technology Support for Collaboration and Learning, Wearable Technologies Mobile learning and Ubiquitous Technologies for Learning.

1 Introduction

The Metaverse has been proposed as a new utopian future of User Interaction and Use Experience (UX/UI). In Mark Zuckerberg's [1] vision of the future, it is a world where people would inhabit an entirely virtual space, parallel to natural reality, but one in which they could engage in all the activities of the real world. In this vision, the metaverse employs high-end virtual realities to realise this utopia. Therefore, common technology associated with the Metaverse in these visionary statements are high specification hardware, software and bandwidth. Clearly such technology has costs associated with it. It is the purpose of this paper to challenge these assumptions and show that for educational purposes much of the same goals and affordances can be achieved with less resource heavy technology and at much lower costs.

Such concerns for Learning and Collaboration are timely and have considerable consequences. The Metaverse for Learning and Collaboration can have direct impacts on embedded and immersed learning, ubiquitous learning, the use of interactive AI and Chatbots, and provide new locations physical, social, and cultural for interaction and collaborative learning. This paper aims to demonstrate how the new world that the concept of the Metaverse opens up can be made available in much more commonplace and cost effective ways. This is not to take anything away from high end, resource rich, technology solutions. For many they will be of great benefit, but we here argue that this benefit is not their soul preserve, and other implementation routes can be equally rewarding and an important step forward in what we provide our students.

VR has been with us for a long time, but still takes up a comparatively small role in UX/UI. Even in computer gaming, it is a limited force, with many games opting for lower technology solutions that give the impression of a larger virtual world. The location of the game does not need full blown VR in order to realise the player's immersion in the imaginary world and/or collaboration. Here in the educational context we will argue that the same ideas can be used to immerse users in a version of the metaverse for learning.

2 The Metaverse Realised as a Metaphor

The metaverse is only a new way of presenting, handling, manipulating and interacting with information. In HCI we have a long history of using techniques in order to scaffold interaction between users and the computer. This might be via a shared imagined space, such as in early all text based games for example. LOGO [2] used the concept of a turtle moving in a space as a basis of interaction as a way to teach maths and geometry to children, doing so in a low resolution media manner. Most famously the Xerox Star system of the late 1970s [e.g. 3] presented us for the first time with a recognizable version of the desktop metaphor. It contained the crucial idea of a graphical user interface, Windows, Icons, Menus, and Pointing (WIMP), allowing direct manipulation of these objects, and enabling a What You See Is What You Get (WYSIWYG) interface. From the Apple Lisa onwards these founding principles underlie the interfaces we see on common interfaces for computers, with the likes of modern Mac, Windows, and Linux desktop systems. They are representative of the desktop as a metaphor only. Hypertext systems (e.g. Hypercard, [4]) or spreadsheets (e.g. VisiCalc, [5]) use a visual model that can stand in for what they purport to represent. They do not need to be just like the real thing and this is enough to enable the types of interaction and ease of use they were designed for. As long as the metaphor is capable of being shared for a given particular purpose then they fulfil the necessary requirements. How the metaphor is implemented in detail may not be critical as such. If we look at early desktop metaphors the icons and graphics were crude in comparison with today and the world appeared literally black and white. However, they were good enough for the purpose. Many icon referents were not obvious and their meaning had to be learnt or guessed because of limits on representations (e.g. 32x32 bit maps implementing them), but once these referents had been discovered they could be used and the metaphor worked accordingly.

The metaverse can thus be thought of as a virtual machine implementing a new metaphor. In the same way that we can use the desktop metaphor to structure the interaction without the need for a VR representation of a desktop, from an information perspective we can achieve the metaverse metaphor without requiring VR. Thus, preserving the interaction benefits of the metaverse metaphor without incurring unneeded overheads in terms of implementation cost. As long as you are in a believable metaverse, and able to do the same types of things, then the type of implementation that supports this is more open. It has to believably support the metaphor. Many different technologies can do this and not necessarily all needing to be high end in terms of cost and bandwidth.

3 Social Media and Social Learning

The background origin of the Metaverse lies in social media, and here we are looking at trying to use it for collaborative learning. Thus it is timely to consider social media and how it can be used for effective social learning.

Initial social media systems were often very low bandwidth asynchronous messaging systems. These ranged from the early email to early chat boards (e.g. Usenet, Byte Information Exchange (BIX, [6]), Compuserve, AOL). Contemporary Social Media Systems can be used in the learning context. For example TikTok is often employed by teachers to present 15 second summaries of teaching session content. In the same vein students can then be encouraged to make short 15 second summaries of important things they have learned from specific lessons. Longer interactions can be supported by tools like Facebook and Twitter, where longer media clips can be easily shared. Groups can be set up and discussion groups created (open or closed), enabling rapid feedback, the use of interaction using polls, and synchronous interactions using Facebook Live (that can be recorded for subsequent further study) or MS Teams. These allow social media tools to be used for social learning.

The recent health crisis caused a rapid shotgun marriage between Social Media and Learning, in that schools, universities, and other places of learning were shut down and all activity was moved online. Initially people had to adapt to what was immediately available e.g. using systems traditionally favoured by gamers like DISCORD for asynchronous chat, or synchronous voice or video communication. Over time institutions became used to employing conferencing tools like MS TEAMS or ZOOM to deliver lectures, tutorial, meetings, and other learning activities. Indeed even as the crisis is over this has persisted as a source of delivery to students.

One of the lessons from all this here is that the metaphor of a virtual university had to be assembled rapidly and using various off-the-shelf technologies, glued together in order to provide the new virtual school or university. Users were able to adapt to this and accept that they now studied virtually at their school or university. All sorts of applications were rapidly assembled to create the metaphor from familiar software (e.g. Powerpoint or Skype) to new video conferencing software and even borrowed PCs. The metaphor could be made to stand up and work. This is the same for the metaverse, its story can be told from many different implementational angles.

Whilst learning can be done individually, the development of learning has been as a social activity, from nursery through primary, secondary and further education, and into higher education (tertiary education). Campus based education typically depends on classes, peer groups and social environments. For online learning, distance learning providers utilise social metaphors and approaches to emulate the classroom environment and to frame learning and support education. Social media provides a mechanism to enable the informal discussions and support networks that complement the formal learning, akin to the extracurricular groupings and activities of traditional learning. Thus social media platforms can support the learner and their learning. With the rise of viable and cost-effective VR technologies, this offers the opportunity to immerse the learner and provide a new environment that can let the learner develop.This offers the potential for a more flexible approach to learning, which can integrate with Virtual Learning Environments (VLE), which are not immersive technologies but act as a metaphor for a learning institution.

Next, if we break down collaborative learning by interactions types and modes (both human-human and human-AI) we can look at the use of social media and learning and the following collaborative contexts:

- embedded and immersed learning
- Ubilearning, including anytime, anywhere *Flexible Learning*
- human-AI collaboration,

To use the metaverse in each of these contexts we can think of what type of information and media we would need.

Each of these types of information and media handling can be satisfactorily done without the need of a high end VR. Indeed many of them are done with existing systems. Our GUIs can do much of this as can our Conferencing systems. In terms of what basic facilities they would need to handle we would need:

- a shared metaphor of interaction,
- shared facts and knowledge about the world,
- a shared set of virtual artefacts and locations,
- a shared virtual machine,
- a mode of working, sharing experiences and communication exchanges.

Whilst each of these types of information manipulation handling and manipulation could be done in a high end virtual reality they can, and are on an everyday basis, done by other lower technology means. Thus from a learning and collaboration metaverse pedagogy perspective, there is no need to just base this on high end specification devices.

4 The Costs and Options for implementing the Metaphor

Early examples of interactive virtual worlds, where users interacted with each other, employed a textual world (for example the game Dungeons and Dragons - a shared text based virtual reality). In this section we present some historical examples of how complex metaphors can be implemented via simple systems. In doing so we present the following as examples of stepping stones into creating virtual worlds that can support the types of activity we need in our educational metaverse.

Low bandwidth VR has been with us a long time and has already been applied in the learning domain. In 1994 The Open University UK ran a Virtual Summer School (VSS, [7]) that had to use the infrastructure of modems and copper twisted wire phone technology to create a virtual model of the sort of residential summer school typically then held on campus of UK universities. Bandwidth was augmented by the use of mobile phones and turn taking software. The Campus was created with a veneer of software on top of the FirstClass Conferencing system. It allowed students to receive lectures and tutorials, have one to one teaching sessions, work together in groups, write simple computer programs, and design and run experiments. Additional Teaching material was presented by Hypercard tutorials. The whole project used a suite of available software packages, assembled together to tell the story of the Virtual Summer School.

An example of a virtual world that was achieved with use of simplified graphics is Second Life. Second Life [8] is a 3D virtual world where multiple users can interact. They do so by creating avatars for themselves and interacting with other people's avatars in shared spaces with resources they have created. An internal market is monetized by the "Linden Dollar". It delivers these virtual worlds on a home computer using a web browser and OpenGL technology. It was originally launched in 2003 and at its peak claimed one million users [9]. The important concept here is that people bought into this "reality" and took it for real despite the reality of lower multimedia. People were able to immerse themselves in this shared world and interact accordingly.

In an educational context, the Department of Information Systems of the University of Sheffield [10] set up an island 'Infolit iSchool' with Second Life. They have used it to teach real students, to present at conferences, and for research purposes as a method of contact and communication between others engaged in this research, and for holding events. In the context of distance education, one of the benefits that is claimed is that the colocation of people's avatars being present in the same virtual world creates a social presence of these other people. This in turn might be a factor in overcoming one of the key issues in distance education, namely that of loneliness and feeling of isolation, leading to poorer performance or in the worst case student drop out. A further potential advantage is that it doesn't matter which country someone is from, it is the presence of their avatar that matters, thus meaning that physical location is not an issue. Several other Universities have set up their own specific islands to teach a number of different subjects including health studies and nursing, history, art and architecture, and Chinese [11].

Another off the shelf application is Minecraft. Minecraft is an example of an interactive virtual word with simplified graphics, of which the virtual world is largely made up of "blocks or cubes" [12], which has been used for educational purposes in a range of subject areas [13]. Although Minecraft is considered as a video game [14], there is an education version [13], known as Minecraft Education [15]. According to [16], the "shared virtual space in the metaverse" [ibid, p. 40] enables learners to "better participate in education". In this regard, [17] carried out a study in which Minecraft was used as an educational tool for facilitating "collaborative learning". According to [17], there is an interest in "computer-supported collaborative learning" [ibid, p. 1] within education, since collaboration is considered to be an essential ability in the modern day.

In [18], to avoid situations in which educational Information and Technology (IT) based content is only accessible to a few teachers and learners, "cross-platform technologies" [ibid, p. 18] should be considered. In this regard, Minecraft is available for different platforms including "Windows, Mac, Chromebook, and iPad" [19], of which users on different platforms can interact within the same virtual Minecraft environment. Therefore, this ensures that those that have challenges accessing or using a particular platform, have alternative platforms that they could use. Furthermore, Minecraft is also supported on Head Mounted Display (HMD) Virtual Reality (VR) platforms, as indicated by [20] who carried out a study in which Minecraft was used in high school classroom settings via the Oculus Rift HMD VR device [20]. In this regard, one of the activities consisted of learners in a science class tasked to collaboratively "build a model of a plant" [20] within the Minecraft virtual environment, and another activity consisted of learners in an ICT class "building a virtual reality cafe" [ibid, p. 22]. HMD devices are a category of VR platforms [21], in which a virtual environment is projected onto displays situated in front of the user, similar to wearable glasses [22], of which case the user's view of the physical world is occluded by the displays in question [21]. 3D virtual environments projected onto HMDs are considered to provide a more immersive experience than virtual environments projected onto conventional display devices such as computer monitors [21, 23], of which within the context of VR, when used for VR, conventional computing devices are categorised as desktop VR [21]. According to [20] there was a "willingness of most students to collaborate" within the virtual environment simulated in Minecraft via VR, which further suggests that an off the shelf application like Minecraft, particularly when used in conjunction with VR, is capable of engaging learners to work collaboratively in a shared environment. However, [20] also note that there was a small number of learners who were not comfortable using the HMD VR device, which further supports the notion that cross-platform applications should be considered for educational purposes.

In the previously discussed study by [20],it states that one of the challenges they faced was accessing the internet in order to use Minecraft, due to the school network having blocked access to the Minecraft application, resulting in the need to find an alternative means of accessing the internet for Minecraft [20]. This highlights the need for low bandwidth technology solutions where reliance on a persistent internet connection is minimised. In this regard, reliance on the internet would potentially result in accessibility and inclusion challenges in a developing country like Malawi, where according to the Malawi Ministry of Education [24], only 2.5 percent of primary schools in Malawi have access to an internet connection. Furthermore, according to the Malawi Ministry of Education [24], 68% (2022, p. 27) of primary schools in Malawi have no access to electricity, while 19% of secondary schools in Malawi have no access to electricity. Therefore, to account for accessibility and inclusion, low bandwidth technologies can be considered for areas facing challenges like those in Malawi, in relation to technology access and use.

Each of the examples in this section show that believable Virtual Worlds can be created in different ways. In several respects, the Virtual Summer School (VSS), experience in different countries, and approaches we saw during the Covid-19 Health Crisis discussed earlier, share the approach of implementing the story of a Virtual School or University by exploiting existing software that can be glued together. Second Life and Minecraft show how believable VR doesn't need to involve High End graphical solutions. The importance is that the end users need to be able to buy into these stories and interact and behave as if they believed they were in that Virtual World. Thus believability is the key to the low end educational metaverse.

5 Why low cost bandwidth and technology solutions are desirable

Low-cost technology solutions can be desirable, particularly in relation to accessibility and inclusion. [25] describes accessibility as "the extent to which an interactive product is accessible to as many people as possible", and refers to inclusion as accommodating "the widest possible number of people". In this regard, high end high-cost solutions could result in accessibility and inclusion challenges in some areas. Specifically,

- Many places do not have the bandwidth currently and this may last well into the future. This may be down to lack of necessary infrastructure or lack of service providers. In more remote or lightly populated areas (for example rural locations) there may be a lack of economic incentive to provide the necessary services.
- Many institutions, such as schools, are already challenged for resources, and will not be able to afford the costs of high end kits now or in the future. For instance, in an underdeveloped country like Malawi (Malawi Government, [26]), rural areas are "where poverty levels are high" (Malawi Government, [26]). In which case, according to the Malawi Ministry of Education [22], 87 percent (2022, p. 6) of primary schools in Malawi, and 80 percent of secondary schools in Malawi, as identified in the 2022 Malawi Education Statistics Report, are located in rural areas [24]. Therefore, considering the prevalence of poverty in rural areas in Malawi [26], the majority of primary and secondary schools in Malawi would potentially face challenges in accessing high cost technologies, more so since the cost of ICT services and technologies is considered a challenge in relation to technology use in Malawi [27,28]
- Many individuals or families will similarly not be able to afford the kit due to financial and other resources challenges. With the shift to flexible learning and working at home, it is important to make this technology available across the range of the domestic circumstances. VR HeadSets and Gloves are relatively expensive items. To be used to their full potential they need higher end home computers, so just having broadband to the house does not solve any of these problems. If we apply flexible learning to large cohorts

then there needs to be adequate provision for all users in all circumstances.

- Low resource solutions widens the range of potential contexts of MLearning and learning on the move. By not assuming that high cost and bandwidth solutions are the only way of delivering your learning goals, you broaden the potential learner base. If we want those learning to be mobile and learn on the move, this can be better realised if we have low resource intensive solutions available for our students.
- There is less to learn if you are coming from a known world into a new manifestation of it, rather than some new, first time, exploratory space. Many learners only have wide experience with low technology solutions. Introducing new technology need not necessarily help the user, indeed new technology can become a barrier with an extra layer that needs to be learnt, making the number of new skills to be mastered much larger than it might be without. Furthermore, there remains more work done to show the benefits of all of this for learning. Just throwing technology at a problem because we can does not in itself make the learning experience better. We know this from recorded experiences with TICCIT and PLATO, where providing computer based learning materials was only beneficial if those materials were pedagogically sound [29]. If we are to increase the learning curve for students there needs to be demonstrable advantages. If low bandwidth alternatives exist which try to do the same thing without the need to buy and learn new expensive technology, this is an alternative solution route for us to follow. The work presented here is a start of that journey of finding low overhead analogous or isomorphic solution routes.

6 Case studies for the use of Low Cost Metaverse for Learning and Collaboration Technologies

The following is a case study of a high end solution to the metaverse in the context of Learning and Collaboration Technologies that demonstrates how this might be realised by other means.

Kambili-Mzembe and Gordon [30] propose an approach of which they showcase how VR technologies can be used to simulate a cross-platform shared virtual environment, for the purpose of school teaching, without relying on the internet or an existing network infrastructure, thereby showcasing the use of low cost and low bandwidth technologies that could potentially be applied to the use of shared environments for learning. In that study [30], Kambili-Mzembe and Gordon present a VR prototype that was developed to showcase a shared collaborative interactive 3D environment, of which a user on a Windows computer, a user on a Android tablet and a user on an Oculus Quest HMD VR device, are able to interact synchronously within the same virtual 3D environment, via a local network setup on a router. According to [29], by supporting both desktop VR and HMD VR devices in their proposed setup, in a way that does not require a particular type of device to be available, if any of the other supported devices are available, allows for readily available devices to potentially be used, thereby potentially addressing cost related challenges. Furthermore, they indicate that enabling multi-user functionality via a local network setup on a router, allows for collaboration between users while addressing cost related challenges since an existing network infrastructure or the internet are not required. The approach proposed by [30] demonstrates how shared 3D virtual environments can potentially be developed and implemented using relatively cost-effective technologies, in areas facing challenges like those faced in Malawi, where as previously discussed, access to high end and costly technologies and ICT services are a challenge.

6.1 Evaluation Methods.

One of the critical things for an interactive learning environment to be effective is that the interaction metaphor to be believable. For example, do the users interact with their low end systems as if they were embedded just like in high end systems? Are they able to do the same types of things and exhibit the same type of learning and collaboration? To determine this would be critical in assessing its effectiveness. One obvious way of looking at this would be empirically via gathering user experiences. The problem here is that because the interaction is potentially new to many users, they may not have the necessary language or observations to answer such qualitative questions. Clearly we could use quantitative methods like marks and drop out rates as measures of academic achievement and engagement. Another approach would be to take existing inspection methods and generalise these. We have looked at the metaverse as a way of interacting, sharing, and behaving and looked to achieve the same types of behaviour by lower technology routes. One way of testing the success of these endeavours is to develop inspection methods that could now probe these questions. As [31] generalised Heuristic Evaluation [32,33] to look at pedagogical aspects of applications, a possible route forward here would be to develop the necessary heuristics which could inspect low bandwidth metaverse solutions and evaluate whether they were fit for purpose.

7 Conclusions and Further Work

This paper started out by defining some of the core critical axes of the Metaverse, first starting with its basic definition, its vision of future interaction design, and the key claims of deliverables that it will bring. It then explored how in the current context it can be applied to learning and collaborative educational technologies. We then focused on the basic underpinning information and media handling concepts. The Metaverse is thus analysed not from a purely technical perspective but from one of information handling, manipulation, and user experience. From this we then looked at how this might be offered, on an information management basis, by different interaction modes. In this way we have looked to demonstrate how the benefits of the Metaverse metaphor may be decoupled from the technology and thereby delivered by a mix of interaction techniques. These techniques in themselves may be flexible in their cost, in terms of technology, availability, and bandwidth. This is a desirable property to introduce both as a way of broadening the potential uptake and roll out of the metaphor, the flexibility it offers in terms of delivery, and the potential for mobile and international learning. In this paper we have argued that it is the concept that is important in exploiting the metaverse more than just the implementing technology per se and that there are different, and viable alternatives to realising and implementing it. We are not against High Specification Technologies but the notion that there is only one way of implementing the Metaverse is not the case. The Education Metaverse is not just in terms of high end VR technologies alone. Instead we have aimed to demonstrate the possibility of using a far wider range of implementation methods. We have argued the role of lower cost technologies that may be employed to achieve similar ends. Indeed we have shown that it is both timely and appropriate to consider these solution routes in order to widen the reach of the metaverse concept and make it a learning and collaboration technology the all may seem to benefit from in the near distant future.

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