LEARNING IN THE METAVERSE

A BRIEF INTRODUCTION

What if...

...you could conduct an astronomy lesson from the deck of the International Space Station? Or teach students about reef restoration while surrounded by colorful coral on the ocean floor?

While it may be a while before we can reach a state of full sensory immersion, these are not just possibilities. These kinds of learning experiences already exist today inside the metaverse. It's a virtual environment built for exploration, gaming, community, and increasingly, education.

While many educators may have heard about the metaverse in the media, few have an in-depth understanding of what it is. Fewer still have used the metaverse in any educational context.

This brief introduction to the metaverse will hopefully introduce you to some concepts, tools, and resources that you can use to further your exploration of immersive learning and innovative pedagogies.

If you would like to learn more about what we're doing in our foray into the world of the metaverse for education, feel free to contact us at **info@keep.edu.hk** or visit **keep.edu.hk** for more information.

Contents

Introduction 1

Metaverse 101 2

Learning in the Metaverse 3

Case Study 8

Tools and Resources 11

References 12

KEEP

香港中文大學 The Chinese University of Hong Kong

Did you know?

- Market cap of Web 2.0 metaverse companies is 14.8 trillion USD
- There are currently 50,000+ users of metaverse virtual worlds.
- By 2026, it's estimated that around 25% of adults worldwide will spend at least one hour a day in the metaverse for work, shopping, entertainment, education, or socializing.
- 29% of global respondents in a poll on the metaverse said that creating "more possibilities in education" is the biggest potential benefit to the metaverse.

Metaverse 101

The metaverse has been around for a while now, but it only recently gained massive momentum in the public consciousness. In 2021, when tech giant Facebook rebranded to Meta, it came with the expectation that the metaverse would soon be everywhere.

Two years later, that hasn't quite happened yet. But there are plenty of innovators working behind the scenes to develop the next generation of immersive technologies that will bring us closer.

The metaverse is a broad concept, so in this document we're going to mostly talk about it in the context of **education**. Keep in mind that the metaverse is also used for:

- Gaming
- Socializing
- Entertainment
- Shopping
- Communication
- Networking

There are many technologies that led to the development of the metaverse. Without the incredible advancement of computer processing, the internet, and VR devices, the metaverse wouldn't be possible.

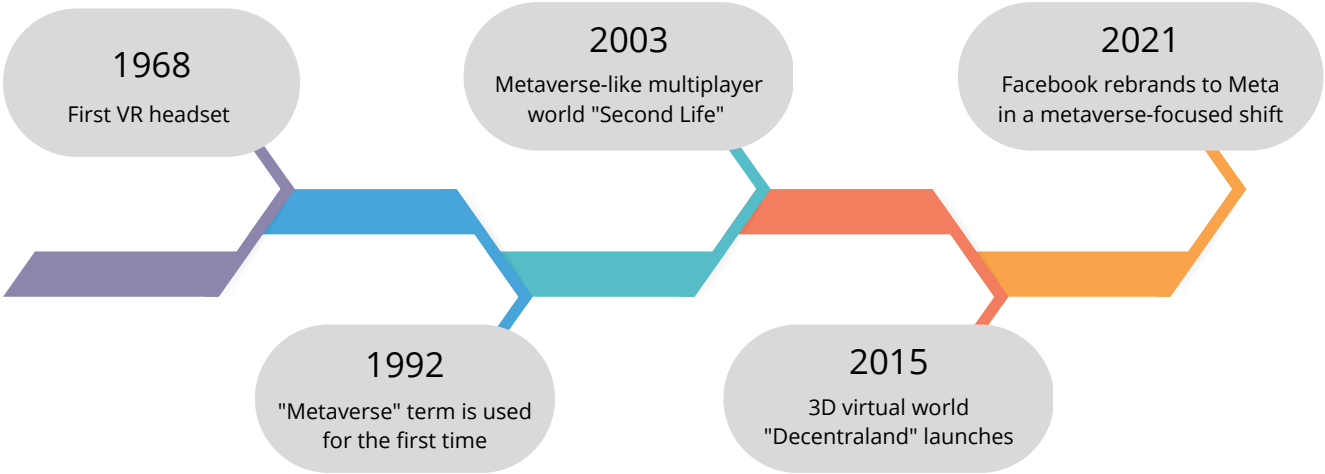
While these technologies were previously limited to commercial applications, they're now accessible to people everywhere. Now, even rural schools can enter the metaverse through mobile devices, as long as they have internet connection.

This has opened up a new frontier for immersive learning in education from kindergarten to university. We'll explore some ways educators are using the metaverse in the following pages.

Key Takeaways

- Neal Stephenson was the first to use the term "metaverse" in his 1992 book, Snow Crash. In it, he described a virtual reality, or "metaverse," composed of various environments for activities such as entertainment, socializing, and learning.
- The Metaverse is a decentralized version of the internet which allows people to communicate, explore, and have fun in a range of virtual realms.

Brief Timeline



Learning in the Metaverse

Immersive Learning

What do we mean when we talk about immersive learning? Ideally, it's a way to immerse learners in a stimulating environment that replicates real-world scenarios or offers a way to experience situations that might otherwise be inaccessible.

Immersive learning aims to facilitate:

- **Active,** not passive learners
- **Memorable** experiences
- **Time-efficient** content delivery
- **Sensory** stimulation
- **Mind-body** connection

But why do we need immersive learning? Teachers already struggle to implement existing education technologies, and these tools are often criticized for poor implementation in institutional frameworks.

Immersive learning should be viewed simply as another tool that can help educators communicate their learning objectives. It is not the end goal for all pedagogical frameworks.

However, it's particularly well suited for lessons that would be covered by the **DICE** acronym: Dangerous, Impossible, Counterproductive, or Expensive. More on this on the next page.

Four Pillars of Immersive Learning

This graphic appears in the publication, "The Ultimate Guide to Immersive Learning" by Strivr.
Follow this link to read more: https://www.strivr.com/resources/ebooks/immersive-learning

DICE Framework

DICE is an acronym created by Jeremy Bailenson, the head of the Stanford Virtual Human Interaction Lab (VHIL). It's a helpful way to think about what kind of learning experiences are best suited to virtual reality. This same framework applies to extended reality technologies and the metaverse in general as a learning environment.

According to Bailenson, if a learning scenario is **Dangerous, Impossible, Counterproductive, or Expensive**, then it may be a good candidate for teaching through immersive learning tools.

Dangerous

Flight simulators were an early precedent of using immersive education to replicate a real-life dangerous scenario. Other examples include using XR to teach firefighting, heavy machinery operation, construction, etc.

Impossible

XR can be used to time travel to historical events, or even used to explore the solar system. Another way it's used is to experience a scenario through an avatar that would otherwise be inaccessible to the user. For example, a man role-playing as a woman, or a person role-playing as a different ethnicity, to learn about discrimination.

Counterproductive

XR could be used to teach about deforestation through the simulation of clear-cutting a rainforest. Or, call center workers could train how to patiently respond to simulated customers rather than stressing over real-life scenarios.

Expensive or rare

XR can be used to cut costs or provide access to rare training opportunities. An entire school could take a field trip to a distant country, or a surgeon could repetitively train for an expensive procedure in preparation for a real patient.

AR (Augmented Reality)

Tool: Mobile device or see-through head-mounted display

Scenario: Architecture students could explore a computer-generated model overlaid onto a real physical location. Multiple students could interact with the same model from their own perspective.

Hardware: Smartphone, tablet, HoloLens, Realer devices, Magic Leap 1, ThinkReality A3

Applications: IKEA Place, Google Lens, Pokemon Go, Snapchat, Instagram, Destination Mars, AR Reef

MR (Mixed Reality)

Many people classify MR as a form of AR. However, MR can also include tech such as full-body motion capture and overlay into a virtual environment. See SMALLab Learning.

VR (Virtual Reality)

Tool: Head-mounted display

Scenario: Mathematics students could enter a metaverse classroom with VR headsets and controllers to interact with 3D graphs and visualizations. Biology students could explore a virtual reef or the bottom of the ocean.

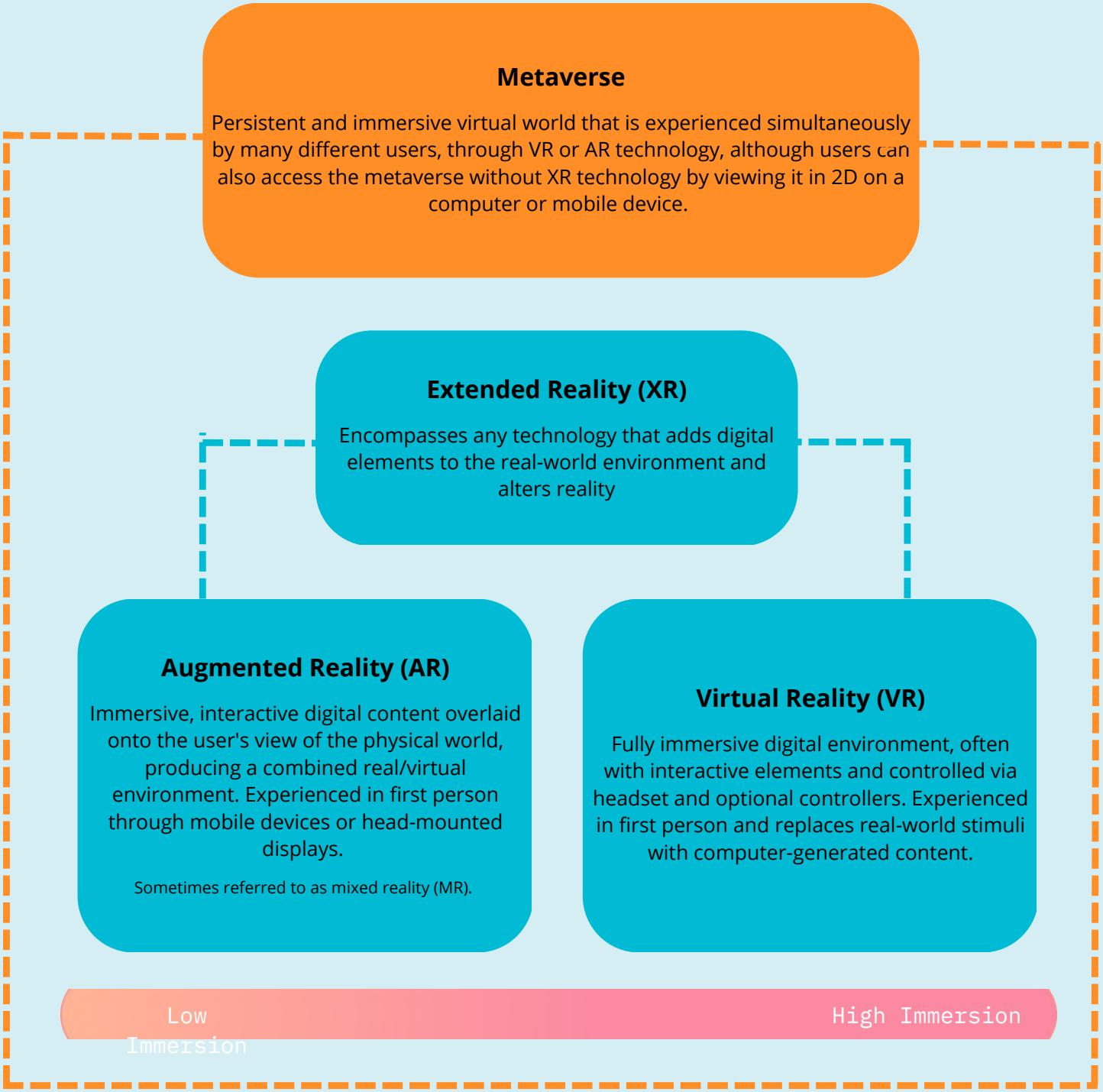
Hardware: Meta Quest 2, HTC Vive, Oculus

Applications: Access Mars, AR Reef, Nanometers, Prisms VR, Tree

What is XR?

XR stands for Extended Reality. It's a key component of immersive learning and encompasses most of the technologies used to access the metaverse. It's a mix of augmented and virtual reality, and covers a broad spectrum of devices from low immersion see-through displays to fully immersive VR headsets and controllers.

The key goal of XR technology when used in education is to build a sensory experience that stimulates learning in a way that is different from traditional methods.



What is XR Good For?

Visualization: XR helps visualize things that are difficult or impossible to see with the naked eye. For example, learners can visually recreate molecular structures or visualize complex mathematical theories.

Gamification: Gamification is already widely used in edtech applications motivate learners. XR takes this one step further by creating a more immersive gaming experience that engages on multiple sensory levels.

Virtual/Augmented Field Trips: There are hundreds of virtual field trips that already exist for educational purposes. These environments can replicate more authentic experiences than text or video and help provide contextual clues that increase information retention.

Real-time Feedback: XR allows for instant feedback based on a user's decision-making. This is valuable for replicating real-world training situations. XR is currently being used to prepare people for jobs in everything from construction to surgery.

Immersive Storytelling: XR is particularly well suited to storytelling. Users can interact with the designed environment in ways that go beyond viewing the story in a linear visual or audio manner. This can be used for teaching history, cultural studies, liberal arts, and more.

Active Learning: The metaverse and other immersive learning environments allow users to create and interact with 3D objects in an active, not passive, way. By engaging the mind-body connection, XR experiences encourage students to use different parts of their brain than they are used to using in traditional classrooms.

Role-Play and Perspective-Taking: XR opens up students to learning from different perspectives. For example, users can role-play in conflict resolution situations as a from of therapy education. Or, they can take part in practical exercises like virtual job interviews to gain valuable, low-risk feedback on their performance.
Repetition: Just like they would do in a game, XR users can repeat lessons or training situations on-demand without extra effort from teachers.

What is XR Not Good For?

Cognitive Load: Sometimes, immersive environments may be over-stimulating, as there is a high level of sensory engagement. Educators should be aware of how much sensory detail is required to convey the material without overwhelming learners.

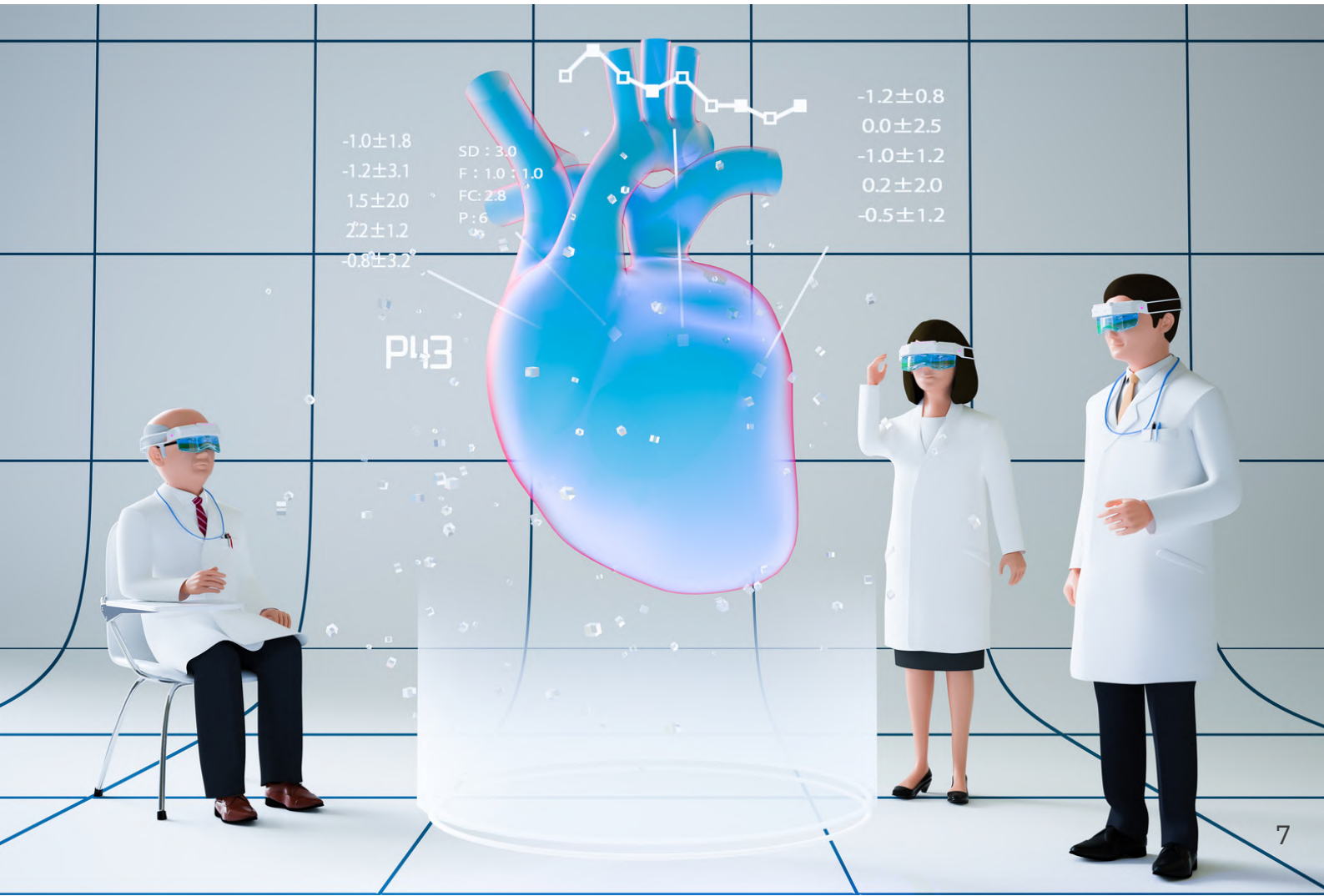
Time Constraints: XR experiences can induce physical discomfort in some users. In particular, VR and MR devices can make people dizzy or nauseous with exposure of longer than 15 minutes. To combat these effects, teachers can utilize XR tools for shorter periods instead of the full lesson. Or, mobile-based AR may be used for longer periods, as it tends to be less uncomfortable for most users.

Lack of Technical Knowledge: Educators without technical skills would need to rely on existing educational content or work with developers to create new material. This latter option can be a time-consuming and potentially expensive process.

Accessibility: XR technology is not equally accessible for all users. In particular, people with physical disabilities may find it difficult to interact with the controllers. Even glasses can present challenges when it comes to finding a comfortable VR goggle fit.

Difficult to Assess Learning: There is still more work to be done in terms of collecting assessment data in a virtual or XR environment. While data such as movement, eye tracking, task completion, etc. can be collected, more research is required before there is an accepted standard of meaningful assessment.

Affordability: The cost of XR technologies may be prohibitive to some learning institutions. There are many things to consider, such as special equipment, training, maintenance, upgrades, storage, and assessing the appropriate number of devices to purchase. In addition, developing new XR educational content can be costly.



Case Study

Prof. Marc Santugini is an Economics professor at the University of Virginia. He's a pioneer in an emerging space where teachers are exploring ways to utilize the virtual world of the metaverse in their academic pursuits.

Since June 2020, Prof. Santugini has been teaching econ in VR. Spring '22 was his 3rd semester of teaching small econ classes in virtual reality. "Over the last three semesters we have learned what works and what doesn't for 'learning in the metaverse.'"

Virtual Classes Have Real-World Positive Outcomes

In January 2022, we interviewed Professor Marc Santugini from the University of Virginia. He's one of the first professors to utilize VR teaching in the metaverse for entire semesters.

He uses Rec Room, a metaverse platform that has millions of users and is usually used for gaming. This platform allows him to build customized rooms, models, graphs, or other learning materials. But it also has hundreds of pre-built template environments to explore as well.

According to Prof. Santugini, teaching in the metaverse allows him to teach concepts that would otherwise be difficult to replicate in the real-world. For example, he can code 3D graphs that animate different functions according to student inputs. The whole class can fly around the graph and explore it in a way that would be impossible to do on a 2D chalkboard. He even had his students code and build a radio in the metaverse that played real songs.

His students have mixed reactions to this teaching method. Some of them are fascinated by the technology and find it motivating and inspirational. Others find it physically uncomfortable or prefer traditional teaching methods.

Either way, Marc is enthusiastic about the future potential of the metaverse for learning applications and believes that the community is active enough to continue pushing the technology forward.

Image credit: Prof. Marc Santugini at The University of Virginia

How to Get Started?

- **Research.** Explore the links in the resource section and read the scholarly work on the metaverse, immersive learning, and XR technologies.

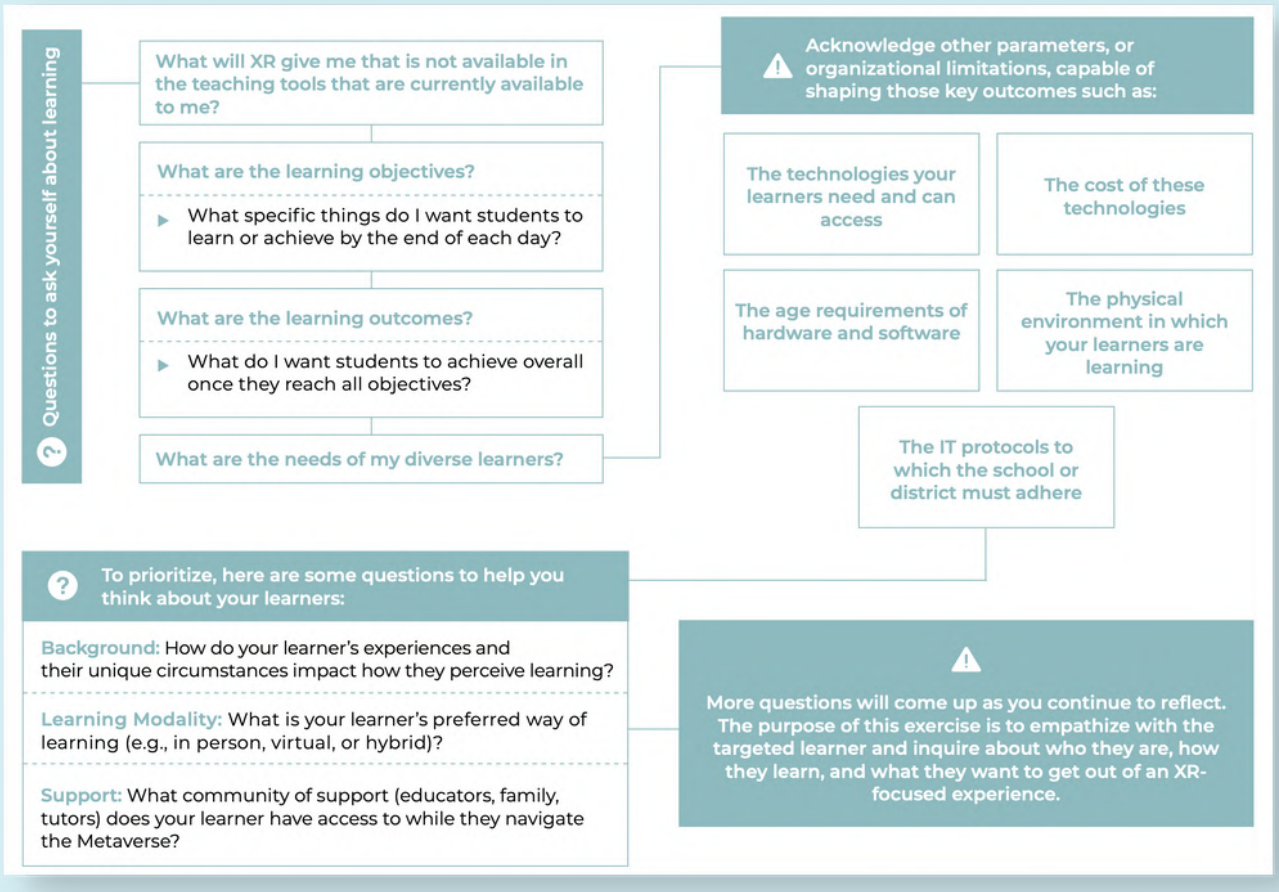
- **Try It.** Contact a colleague or department that has access to VR equipment and see if they have any educational resources you could explore. Experiencing it for yourself will be a good way to know if it's right for your learning needs.

- **Be Intentional.** Immersive learning is a bit of a buzz word these days, but don't jump on board just to be a part of the trend. Consider what the metaverse or XR technology can offer that doesn't exist in your existing toolbox.

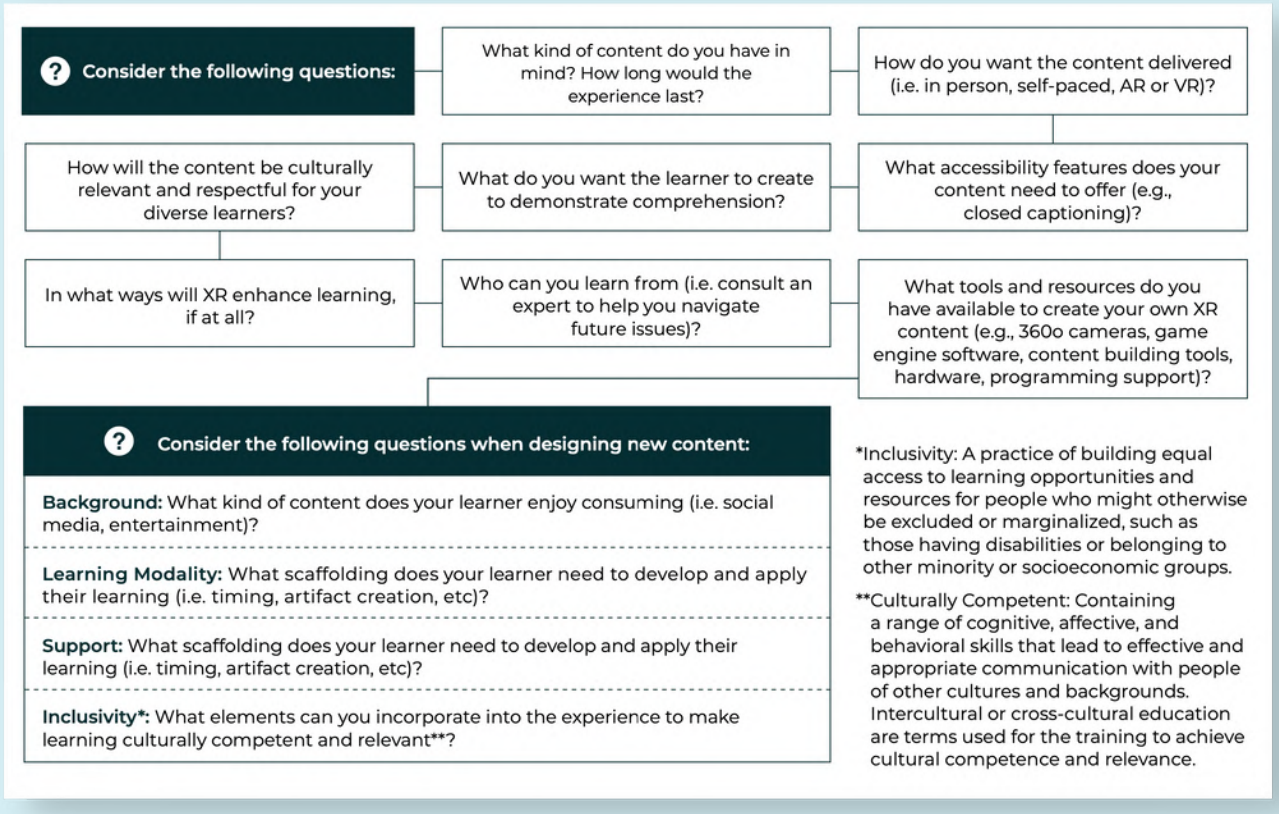
- **Put Students First.** Ask yourself how this will benefit the students and what kind of technology is accessible for your needs. What specific objectives will be accomplished if your students use this technology?

- **Start Slow.** Try incorporating a small VR/AR segment in your existing curriculum and get feedback. Immersive learning is often intended to be conducted in smaller doses.

Exploring Metaverse Education Design



Example Metaverse Education Design Process



The diagrams shown here were published in "The Metaverse for Education" by Meridian Treehouse. For a deeper dive into the educational design process for the metaverse, follow this link: https://www.meridiantreehouse.com/metaverse-education-guide

Immersive Learning Resources

*This is not a comprehensive list, nor a form of endorsement. Feel free to explore the following resources and suggest any resources for us to include in the future.

3D Organon VR Anatomy: VR anatomy learning experience for medical education

Access Mars: the real surface of Mars recorded in 3D VR by the Mars Rover

Appollo 11 VR: Re-live the Appollo moon landing mission in virtual reality

AR Reef: Interactive AR reef experience created by the Smithsonian and Adobe

Art Plunge: Immerse yourself in the world's greatest paintings through VR

Circuit Stream: Courses for learning how to develop XR applications

ClassVR: Integrated student-friendly VR headsets pre-loaded with educational VR and AR resources

CoSpaces Edu: AR and VR tools, spaces, and experiences for the classroom

CRISPR Field Trip: 360-degree video tour of a CRISPR DNA editing laboratory

Educational VR Apps Database: Stanford University-curated database

Educators in VR: Global community, workshops, and articles for educators who are interested in VR teaching

Eduverse: K-12 metaverse with hundreds of pre-built explorable educational experiences

ENGAGE: Metaverse platform allowing educators and professionals to build virtual worlds

Everest VR: VR film allowing viewers to immerse themselves in an expedition to Mt. Everest

Kai XR: Hundreds of virtual fieldtrips geared towards K-12 students

Labster: Interactive VR lab with hundreds of science education simulations

Let's Explore: Interactive underwater VR/AR experience

Mission:ISS: Virtual reality exploration of space and International Space Station

Molecular Web: Chemistry and biology education through AR modeling

Nanome: VR molecular design for chemistry or pharmaceutical exploration

Prisms VR: Immersive VR environment for math education

SketchAR: Augmented reality drawing mobile app

SMALLab: Interactive mixed reality educational experience aimed at K-12 students

Tree: VR experience allows users to experience life as a tree, from seedling to rainforest giant

Virtual Medicine Platform: VR anatomy explorer for different levels of education

Zoe: No-code 3D environment/metaverse creation platform

References

1. https://www.statista.com/topics/8652/metaverse/#dossierContents__outerWrapper
2. Thompson, M., Uz-Bilgin, C., Tutwiler, M. S., Anteneh, M., Meija, J. C., Wang, A., Tan, P., Eberhardt, R., Roy, D., Perry, J., & Klopfer, E. (2021). Immersion positively affects learning in virtual reality games compared to equally interactive 2D games. Information and Learning Sciences, 122(7/8), 442–463. https:// doi.org/10.1108/ILS-12-2020-0252
3. Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment*, *1*(1), 20–20. https://doi.org/10.1145/950566.950595
4. Klopfer, E. (2017). Massively multiplayer online roleplaying games and virtual reality combine for learning. In D. Liu, C. Dede, R. Huang, & J. Richards (Eds.), *Virtual, augmented, and mixed realities in education*. Springer Nature.
5. Wang, P., Wu, P., Wang, J., Chi, H.-L., & Wang, X. (2018). A critical review of the use of virtual reality in construction engineering education and training. *International Journal of Environmental Research and Public Health*, *15*(6), 1204. https:// doi.org/10.3390/ijerph15061204
6. Ihlenfeldt, W. D. (1997). Virtual reality in chemistry. *Molecular Modeling Annual*, *3*(9), 386-402. https://doi.org/10.1007/s008940050056
7. Thabet, W., Shiratuddin, M. F., & Bowman, D. (2002). Virtual reality in construction: A review. *Engineering computational technology*, 25-52.
8. Dede, C., & McGivney, E. (2021). Lifelong learning for careers that don't exist. In *Reimagining digital learning for sustainable development* (pp. 36-44). Routledge.
9. Slater, M., & Sanchez-Vives, M. V. (2016). Enhancing our lives with immersive virtual reality. *Frontiers in Robotics and AI*, *3*. https://doi.org/10.3389/frobt.2016.00074
10. Queiroz, A. C. M., Nascimento, A. M., Tori, R., & da Silva Leme, M. I. (2018). Using HMD-based immersive virtual environments in primary/K-12 education. In D. Beck, C. Allison, L. Morgado, J. Pirker, A. Peña-Rios, T. Ogle, J. Richter, & C. Gütl (Eds.), *Immersive Learning Research Network* (pp. 160–173). Springer International Publishing. https://doi.org/10.1007/978-3-319- 93596-6_11
11. Reilly, J. M., McGivney, E., Dede, C., & Grotzer, T. (2021). Assessing science identity exploration in immersive virtual environments: A mixed methods approach. The Journal of Experimental Education, 89(3), 468–489. https://doi.org/10.1080/00220973.20 20.1712313
12. Thompson, M., Uz-Bilgin, C., Tutwiler, M. S., Anteneh, M., Meija, J. C., Wang, A., Tan, P., Eberhardt, R., Roy, D., Perry, J., & Klopfer, E. (2021). Immersion positively affects learning in virtual reality games compared to equally interactive 2D games. *Information and Learning Sciences*, *122*(7/8), 442–463. https:// doi.org/10.1108/ILS-12-2020-0252
13. Johnson-Glenberg, M. (2017). Embodied education in mixed and mediated realities. In D. Liu, C. Dede, R. Huang, & J. Richards (Eds.), *Virtual, augmented, and mixed realities in education*. Springer Nature.
14. Dede, C., Jacobson, J., & Richards, J. (2017). Chapter 1: Introduction: Virtual, augmented, and mixed realities in education. In D. Liu, C. Dede, H.-M. Huang, & J. Richards (Eds.), *Virtual, Augmented, and Mixed Realities in Education*. Springer Nature.
15. Greenwald, S. W., Kulik, A., Kunert, A., Beck, S., Fröhlich, B., Cobb, S., Parsons, S., Newbutt, N., Gouveia, C., Cook, C., Snyder, A., Payne, S., Holland, J., Buessing, S., Fields, G., Corning, W., Lee, V., Xia, L., & Maes, P. (2017). Technology and applications for collaborative learning in virtual reality. In Smith, B. K., Borge, M., Mercier, E., and Lim, K. Y. (Eds.). Making a Difference: Prioritizing Equity and Access in CSCL, 12th International Conference on Computer Supported Collaborative Learning (CSCL). Philadelphia, PA: International Society of the Learning Sciences.
16. Wu, B., Yu, X., & Gu, X. (2020). Effectiveness of immersive virtual reality using head-mounted displays on learning performance: A meta-analysis. *British Journal of Educational Technology, 51*(6), 1991–2005. https://doi.org/10.1111/bjet.13023
17. Meyer, O. A., Omdahl, M. K., & Makransky, G. (2019). Investigating the effect of pre-training when learning through immersive virtual reality and video: A media and methods experiment. *Computers & Education*, *140*, 103603. https://doi. org/10.1016/j.compedu.2019.103603
18. Murray, J. F. (1988). New technology and educational television. *Journal of Educational Television*, *14*(1), 5–25. https:// doi.org/10.1080/0260741880140102
19. Harley, D. (2020). Palmer Luckey and the rise of contemporary virtual reality. *Convergence*, *26*(5-6), 1144-1158. https://doi. org/10.1177/1354856519860237
20. Jun, H., Miller, M. R., Herrera, F., Reeves, B., & Bailenson, J.N. (2020). Stimulus Sampling with 360-Videos: Examining Head Movements, Arousal, Presence, Simulator Sickness, and Preference on a Large Sample of Participants and Videos. *IEEE Transactions on Affective Computing*, 1–1. https://doi. org/10.1109/TAFFC.2020.3004617
21. Stanney, K. M., Hale, K. S., Nahmens, I., & Kennedy, R. S. (2003). What to expect from immersive virtual environment exposure: Influences of gender, body mass index, and past experience. Human Factors: *The Journal of the Human Factors and Ergonomics Society*, *45*(3), 504–520. https://doi.org/10.1518/ hfes.45.3.504.27254
22. Mado, M., Fauville, G., Jun, H., Most, E., Strang, C. & Bailenson, J. N. (2022). Accessibility of educational virtual reality for children during the COVID-19 pandemic. *Technology, Mind and Behavior*. See: https://www.stanfordvr.com/edvrapps/
23. Yen, Y.-C. G., Dow, S. P., Gerber, E., & Bailey, B. P. (2017). Listen to others, listen to yourself. *Proceedings of the 2017 ACM SIGCHI Conference on Creativity and Cognition*, 158–170. https://doi. org/10.1145/3059454.3059468
24. Hirsh-Pasek, K., Zosh, J.M., Hadani, H.S., Golinkoff, R.M., Clark, K., Donohue, C., & Wartella, E. (2022). A whole new world: Education meets the metaverse. Center for Universal Education at Brookings.
25. Reed, N., & Joseff, K. (2022). Kids and the Metaverse: What Parents, Policymakers, and Companies Need to Know. San Francisco, CA: Common Sense.