SITUATIONAL XR: ARE THERE MORE THAN ABSOLUTES?

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ABSTRACT

The need for digital transformation is in high demand, and Extended Reality (XR) is increasing in popularity within education, business, healthcare, and entertainment. More clarification is needed on how XR can be used for meaningful experiences. In this typological article, we explain the various classifications inherent within XR environments and provide situational theory as a supportive framework for further exploration of XR. We describe definitive learning strategies and technological possibilities in light of these developments. Various strategies can be implemented to assist educators on how to use the technology under the situated learning paradigm. Situativity is relevant to life-changing digital experiences, but many question how to implement it in light of XR trends. Given the challenging climate that organizations face today, situated learning has been an essential perspective for future experiences with XR.

Keywords: extended reality, situated learning, augmented reality, authentic learning, virtual reality, experiential learning

INTRODUCTION AND PURPOSE

Extended Reality is an expansive, global trend with ongoing development in the public and private sectors. What exactly is it? Extended Reality (XR) refers to environments that contain Augmented Reality (AR) or Virtual Reality (VR). Under AR, a user experiences simulated objects that overlay in a real-world environment, whereas VR provides a simulated environment for users to explore. At this moment, there are 3.4 billion phones that have advanced XR capabilities installed on them and ready to use (Ortiz & McGiffin, 2021). AR has been popularized by apps including Pokémon Go and Nike Fit (Ortiz & McGiffin, 2021; Wendt, 2020). Augmented filters are often available in camera-based sharing apps (e.g., Tiktok and Snapchat).

VR is used for a variety of purposes. It is frequently utilized in training simulations in a variety of disciplines including education, business, sports, and medicine (Checa & Bustillo, 2020). VR-based training has allowed employers to save time and increase workforce proficiency by at least 40% (Raghavan et al., 2018). VR is commonly linked with such equipment as the HTC Vive, Oculus Quest, Google Daydream, Unity 3D, Unreal Engine, and PlayStation VR (Checa & Bustillo, 2020; Najjar, 2020; Ortiz & McGiffin, 2021).

An advantage of XR is that using either form does not have to be mutually exclusive. To limit the capabilities of VR and AR as two separate choices does a huge disservice to the potential of XR (University of California, Berkeley, 2021). Today, there are a myriad of technologies that are used to create, imitate, and simulate different worlds, all of which contribute to a variety of new experiences. There are specific ways to approach XR so that it can be expanded and improved upon for learning. Our purpose is to explain XR and its possibilities, strategies, and challenges. Throughout our discussion, we will provide

evidence-based practices to answer a fundamental, yet simple question about its capabilities: Is there more to XR than the pre-existing classifications of AR and VR?

AN OPEN MIND FOR THE XR UMBRELLA

XR is not a new phenomenon. Historically speaking, the first attempt at XR dates back to 1838 with the use of the VR stereoscope in England (ICRC Innovation Board, 2018). Advances in VR have highly influenced the development of AR. Extended reality includes AR and VR, but it also involves Mixed Reality (MR) and any future technologies that arise as a result of the XR experience (Marr, 2019; Scribani, 2019; Wendt, 2020). A more specific way of putting it is that XR "can also refer to any current or planned human-computer interface that builds upon the relation of graphic technology with a wearable device" (ICRC Innovation Board, 2018, p. 2).

The MR capabilities essentially bridge the gap between AR and VR. One of the most popular MR devices is the Microsoft HoloLens. Users can interact with digital objects in the real world and modify them in real time with the HoloLens (Marr, 2019). A specific example of this is the Spectator View app, where users experience a third-party perspective of what occurs in real time (Scribani, 2019, para. 7). It is possible to have all these technologies in one all-encompassing XR experience. Devices such as the Oculus Quest and Samsung Odyssey+ are making this a viable and relatively inexpensive option for users.

An additional, more current perspective to consider is that XR is not just used in a technological context. The technology has existed in videogaming, healthcare, engineering, education, and military training (ICRC Innovation Board, 2018; Scribani, 2019). In the 21st century, the estimated market size for XR was $27 billion for 2018, with a projected growth of $209.2 billion for 2022 (Scribani, 2019). Stewart et al. (2020) actually put the global expenditures for VR and AR technologies at $12 billion for 2020, with a projected growth of $73 billion by 2024. Significant growth has occurred in XR technologies and is not likely to stop any time soon. What distinguishes XR from its subsets is that it is utilized for powerful, transformative experiences that are relatable to the user so that it extends our reality and its various contexts (Coltekin et al., 2020).

It is worth noting, however, that the current use of XR does have its share of challenges that need to be resolved. Commonly reported problems focus on the fact that there are limitations on rendering capacity, episodes of discomfort after viewing, contradictory experiences for users, issues with accessibility, concerns about the lack of complex engagement during XR-based learning tasks, and limitations on the availability of the technological resources (Bonasio, 2019; Hamilton et al., 2021; Pellas et al., 2020). Future XR developers need to be experts in Unity, Unreal Engine, Apple AR Kit, and Android AR Core (Ortiz & McGiffin, 2021).

According to Marr (2020), there are five upcoming trends that require more understanding:

- Increasing industrial use so it outpaces the entertainment industry,
- Increasing innovations in healthcare,
- Developing smaller headsets with more powerful processing capabilities,
- Increasing the educational adaptation of XR, and
- Transferring data more easily through 5G and cloud technologies.

For XR to be truly game changing, relevant decision-making paradigms are required that encourage exploring the idea of contexts. Incorporating situational learning provides the framework needed for such exploration, which in turn can help address current drawbacks in XR technologies.

SITUATIVITY AND XR

Simulated environments can address things within cultural, ecological, political, social, and moral contexts and can be tailored to individual students and to groups. To "expand reality" as we know it requires a knowledge of different contexts and environments. Incorporating situated learning experiences can extend learning within an XR environment. The COVID pandemic is an example of a cultural, situational challenge that many markets must face when facing digital transformation (Tata Consultancy Services, 2020a, 2020b).

Approximately 74% of businesses that are undergoing digital transformations are more likely

to face cultural challenges than technological challenges (Jabil, 2018). This means that workforce culture becomes be a harder problem to solve for most companies, even if the technological situation also has difficulties. Situated learning about COVID would help people understand the overall impact the pandemic is having on society as a whole. Using situativity provides more training opportunities to those who would otherwise be inexperienced with how to deal with cultural issues.

At its core, situated learning is a real-world learning experience that has a context, involves everyday routines, and includes different perspectives (Durning & Artino, 2011; Goodman, 2010; Hutchins, 2010). This learning approach emphasizes that people learn according to the circumstances in which they find themselves, and they adapt according to how they interact with those circumstances (Flynn et al., 2013). This goes beyond typical authentic learning because it calls for a discussion about change and development within oneself, with others, and with the world around the person. The situational learning began with significant contributions from James Gibson (1978) and Jean Lave (1988) and further developments by Barbara Rogoff, James Greeno, and Lauren Resnick (Gessler, 2009, p.1613). The theories of pragmatism and constructivism also helped lay the foundation for the movement (Gessler, 2009; Hung & Chen, 2001; Lubin & Ge, 2012). This approach has been referred to as situated cognition, situativity theory, distributed cognition, an ecological approach, and ecological psychology (Durning & Artino, 2011; Goodman, 2010).

Situativity can expand on experiential learning theory, which is often equated with learning by doing or learned experience (Ord, 2012). Experiential learning is often depicted as two continua of experiences that are used to explain the concrete, abstract, active, and reflective approaches to learning (Jenkins & Clarke, 2017; Schott & Marshall, 2018; Seaman et al., 2017). Knowledge, in the context of this theory, is a process of gaining raw experiences and then transforming those experiences into ideas to build more knowledge. In this process, the learner must decide between two modes of getting new experiences and two modes of transforming experiences. The two modes of getting new experiences are concrete experience and abstract conceptualization, and the two modes of transformation are reflective observation and active experimentation (Jenkins & Clarke, 2017). These four modes create a dynamic cycle of learning development where a student encounters a concrete experience, reflects on that experience, generates ideas, and becomes an active experimenter (Schott & Marshall, 2018). There are other ways of explaining the cycle, such as Do-Review-Plan or individual-environment transactions (Ord, 2012).

Experiential learning is frequently associated with workplace success, but experiential learning is not the only theory that advocates learning by experience. Rather than being permanently caught up in a wheel or a transactional view of learning, it is pertinent that students view experience as an expansive process that can be interpreted in different ways. There can be wheels, pyramids, cubes, and any other concepts for modeling or visualizing learning that are found to be culturally appropriate within a given experience. Raw discoveries can take place during reflection and experimentation, which generates further possibilities for learning.

Furthermore, situational theory stresses that what is learned needs to have a real-world connection (Huang et al., 2014). If it has no connection to the real world, then it loses meaning and actual usefulness. Even abstract learning can be better understood by using visualizations, models, and real-world examples. For instance, let us imagine that a student says, "How does this concept apply to me? When will I use this in real life?" Educators hear these questions in real life from students who are tired of hearing about the same things repeatedly. Students want to know the significance of what they learn. A situationist would say that a teacher should not teach a concept unless these questions can be answered about it. There has to be a broader context available for the concepts being taught. Otherwise, learning becomes more difficult than it has to be to the point where nothing substantial can be done with the knowledge obtained (Huang et al., 2014). Situationism has been categorized as social constructivist in nature due to its focus on authentic tasks with individuals and groups; however, the need for established constructs, context, and culture is why it is often classified

as a standalone theory that can be used alongside other theories (Hung & Chen, 2001; Langer, 2009; Lubin & Ge, 2012).

NOTABLE SITUATIONAL STRATEGIES FOR EDUCATION

One situational learning method that can be useful, especially within educational settings, is to know, experience, and discuss organizational structure. Foucault (1980), for instance, thought of knowledge and power as influencers in the rules, regulations, and experiences of individuals. Power in itself was thought of as a distributive, systemic web wherein people are connected. To share and communicate knowledge via discourse would determine what was appropriate within various levels of an organization. In other words, discussions in and of themselves can help to identify the contexts inherent within a particular organization. Dialogues between individuals and virtual assistants, for example, can become Situated Interactive MultiModal Conversations (SIMMC), where there are task-based dialogues that guide individuals on how to achieve specific goals (Moon et al., 2020).

Another situational strategy was recommended by Ann Brown, who is known for being the key person to espouse classroom use of situativity (Langer, 2009). This strategy was known as reciprocal teaching, which is often used as a way to build communication and other language skills. Six people would get together as a group, and they would take turns sharing information. Each person would act as leader. They would complete these four steps: (a) asking a question at the beginning, (b) allowing for clarification opportunities, (c) asking for predictions about future material, and (d) summarizing the main argument or point of the content at the end.

A third situational strategy is the interview. Interviews can be used to study phenomena and various ways of life. An example of situational interviewing was explored by Grey (2012). Six people who were associated with the Salvation Army, Australia Eastern Territory, were interviewed in order to determine the extent to which divine calling played a role in their identity formation. It was found that the interviewees viewed leadership status and soldier status in the Salvation Army as something called upon by God, meaning that it was ordained as a part of their life mission. The calling to serve God through their positions was an experience that was deeply personal, emotional, and unique to the participants.

It is possible to design a curriculum that includes situated learning and technology. Clinton and Rieber (2010), for instance, designed an effective three-course studio curriculum for instructional technology students in a Master's program. The focus of the curriculum was multimedia design of environments, client personalization, and team-building multimedia projects. The major underpinnings for the curriculum were constructionism, situated learning, and self-directed learning. Wu et al. (2011) utilized a situated learning system within an English language curriculum for Taiwanese university students. The system was a ubiquitous learning experience where mobile devices, with the help of Wi-Fi connections, had access to the learning system. Data were collected using students' information about their skills, abilities, and location. From that, appropriate materials were chosen for those who used the system. There was also a reading guidance mechanism that provided additional support for students who had access to it. Students who used the learning system along with guidance had the highest learning performance outcomes during the study.

STRATEGY RECOMMENDATIONS FOR LEARNING WITH XR

The aforementioned strategies can be improved upon through XR experiences. Having an app, a virtual meeting, or an immersive world for interaction, in addition to using the strategies above, would extend learning. For a more immersive gaming experience in general, Thompson (2018) recommends such ideas as virtual field trips, flipped classrooms, Oculus Rift activities, and MIT's Collaborative Learning Environments in Virtual Reality (CLEVR) game. Figure 1 shows other creative XR-based strategies sorted by subject.

We created the examples listed in the figure to show the general, practical applications of XR technologies. The subjects give each task a different context. The technologies that are typically available to Biology students for academic tasks may not be the same as the technologies available for Finance students. It is possible to use

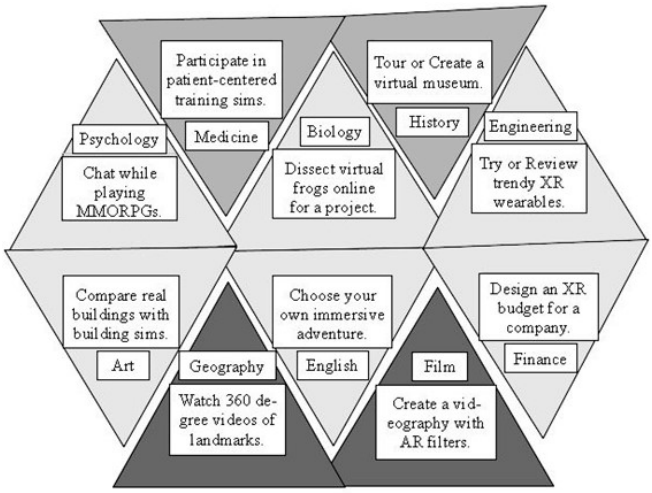

Figure 1. XR-Based Examples of Learning Tasks Sorted by Subject

these learning tasks with other subject areas, but the subjects listed would be the preferred ones. For instance, using videography with AR apps could be something that Communication majors, Education majors, and Physics majors would benefit from in their assignments. Film majors, however, need to be able to do videography to help them with actual film development.

For a more specific scenario, imagine a student wants to talk about the development of paint and paint-related products. A situated XR experience would allow the student to not only learn about paint but expand on their knowledge of painting walls, choosing the appropriate colors, placing those colors on apps, designing scenarios and environments where paint is needed, participating in virtual environments and games about painting adventures, discovering the scientific implications of paint in real-world environments, and designing new environments that add engagement to the real world. Ortiz and McGiffin (2021) mentioned the Sherwin-Williams ColorSnap Visualizer as a possibility for AR exploration. Kessler (2019) suggested the IKEA and Houzz apps for virtual experiences with home decoration.

For a nontraditional viewpoint, it is possible for students to explore the Grand Theft Auto series of games to provide a nontraditional context with painting. In many of the games, a simple VR paint job in a Pay 'n' Spray shop saves the main characters from doing hard time for a long list of crimes. That in and of itself brings up a lot of questions about problem-solving within various contexts. The use of cheat codes and walkthroughs is something that can be discussed as well. There are plenty of codes out there for invincibility, clothing, weapons, health, cars, cash, and anything else important to the success of the game. There are also people who create walkthroughs of games to make things easier for other gamers, which may be seen as good or bad depending on the perspective.

To further clarify these points, let us expand each of the situated learning strategies listed in the previous section: Foucault's (1980) suggestion of using discussions for situational context, Brown's (1994) and Langer's (2009) mention of reciprocal teaching, Grey's (2012) encouragement of the interview strategy, and the development of situated learning curricula as seen by Clinton and Rieber (2010) and Wu et al. (2011). Foucault's (1980) recommendations could apply to any virtual setting as long as a discussion can take place. As previously stated, discussions would reveal the features, structures, and contexts actually available within an organization. This means that individuals participating in actual conversations within any environment would be able to confirm and change contexts during communications.

For instance, Moon et al. (2020) discovered in their research on SIMMCs that conversations about furniture and fashion between a human and a virtual digital assistant could change context according to what was said. If a user told an assistant to move a piece of furniture or search for a piece of clothing to buy, the environment would be changed by the assistant to complete the task. The user would then continue the conversation, if needed, to create the desired outcome. If a function or task is not available within a given environment, the conversations within the setting would reveal this. From there, the creators of task-based environments would be able to develop better virtual and image-based environments that provide more complex tasks than those used previously.

Donaldson et al. (2020) found that comparisons between real-world rock sites and those found through virtual worlds would be relevant for current curricula about the geosciences. Students can compare Google Earth or virtual rock gardens with the actual physical environments. Comparisons can be performed mentally, out loud, or in writing. Situativity within geoscience instruction support the following strategies:

learning communities, mentoring, comparison, contrast, kinesthetics, reflection, representation, and learning contexts. So, not only do students need direct conversations, but they need to participate in activities where there are inherent power struggles, tutorials, text discussions, and SIMMCs. This can be easily accomplished through the use of worlds such as the ones found in Minecraft, Ruby Rei, and situational leadership games (Cambridge Assessment English, 2019; van Dijk & Voigt, 2012). One very popular method of discourse online is the use of social media, particularly the use of social media streams where viewers can see others play games and participate in games themselves.

It is important to re-emphasize that the use of situational interactions is not just for classroom settings. They can be used to help with sales and service as it relates to XR. Those who find COVID to be especially challenging at this time would benefit from resilience-building strategies that would facilitate further interactions with others. Tata Consultancy Services (2020b) found in their survey of nearly 300 enterprise executives that most of the companies surveyed were not fully prepared for the pandemic. Many of the companies lacked six key digital capabilities that would have helped them at this time:

- Delivery of an end-to-end digital customer experience (CX).
- Highly automated core business processes.
- Key partnerships in digital ecosystems.
- AI-based analytics to improve the CX.
- Core enterprise systems in the cloud.
- Digital sensors tracking products.

At least 73% of companies within each category that did not have these capabilities. The highest compliance percentage was the availability for core enterprise systems in the cloud, of which 27% of businesses had that capacity. The lowest compliance percentage was, having key partnerships in digital ecosystems at 21%. Microsoft (2020) gives additional credibility to these survey findings because they identified similar business strategies that help deliver meaningful engagements in changing conditions:

- Track the pulse of customers and employees.
- Create experiences that create customer trust.
- Respond to customers quickly during a crisis.
- Create a remote sales organization.
- Establish a remote service team.
- Protect your revenue and reputation.
- Keep your frontline workers safe.
- Enable remote monitoring and proactive maintenance.

These strategies would be noteworthy for any organization. For school systems and institutions of higher education, stakeholders need to be able to take these strategies into account. Teachers and other leaders need to know the current state of education and create experiences personalized to their audiences. Their response to crises would be dependent upon the circumstances. Not all quick responses are good responses, but there should be a way to mitigate the challenges posed by whatever problematic situation occurs. Having a student service plan, organizational protection plan, and safety plan in place before crises hit would make it easier for solutions to occur more efficiently than not having a plan at all.

Brown's (1994) and Langer's (2009) reciprocal teaching suggestions can be done through avatars, social profiles, and chat rooms to make reciprocal teaching more interesting. A major extension to this learning strategy is to have students participate in games with group and chat features, such as massively multiplayer online role-playing games (MMORPGs). There are well-known VR MMORPGs called OrbusVR and Orbus VR: Reborn designed for VR technologies like the Oculus Rift/Quest and HTC Vive that could be an avenue for educational XR experiences and XR research.

The interview experience can take place virtually or in person. Being able to set up a safe immersive world or chat space exclusively for live interviewing would help extend typical experiences with interviews. This can be accomplished through apps such as ImmersedVR or Virtual Speech. Interviewees also can be set up to use Snapchat filters, drawings, and pictures during interview phases to relay emotions about various concepts. For instance, Grey (2012) could

have used this technology to ask the interviewees if there were ways to depict how they felt or reacted when receiving, resisting, or accepting their divine calls to the Salvation Army. The creative interpretations could have been used to supplement what was already recorded and written according to word-of-mouth. Using Skype, Webex, and Zoom could have been alternatives to typical face-to-face chat that would have had more interactive features available.

Role-playing opportunities with games would be helpful here when exploring interviewing with students. One popular game that demonstrates this well is Among Us, where there can be impostors and regular players. Everyone has web discussions during the game to determine who is an imposter. The imposters eliminate players in a Whodunit fashion until either the imposters are eliminated or the imposters win. It is possible to have an interview within the game where those who are impostors could be interviewed or those who are regular players can be interviewed. If there is not enough time to do an interview during the game, it could be rescheduled for times outside the game.

Sports games can help with role-play as well. Guerreiro Farias et al. (2019) conducted a study to determine if there were improvements in gameplay and performance for 26 students in seventh grade who participated in a Sports Education program. Digital video was created of basketball, handball, and football experiences within specific situational constraints in terms of instruction, engagement, and game modifications. It was found that game play and performance improved over time, but any noticeable findings were limited to the specific situational contexts found in the study. An XR study about this could involve having students participating in sessions of immersive gaming within sports-based gaming environments. These game sessions could be recorded with an app or any video-recording device. Researchers could compare what happens within virtual environments to what happens in real life and see if there are any notable differences. The roles students play during all sports sessions could be documented so that comparisons can be made between the environments used.

A curriculum based on situativity can have many interactive components. Situational courses, including the courses found in Clinton and Rieber (2010), can benefit from the use of cognitive apprenticeships, anchored instruction, and jigsaw activities. Cognitive apprenticeships are practicum-based experiences where students would need to have intensive skills training or specific on-the-job internships with experts in the field. This and other tutoring situations fit in well with a situated curriculum, which supports learning through practice and interdependent social relationships (Gessler, 2009; Orsmond & Merry, 2017). Anchored instruction occurs when a scenario is presented to students, and students find ways to solve problems, model solutions, and question the content from the scenarios given (Moore et al., 1994). Scenario-based learning can occur within a virtual setting through the use of simulations and virtual modeling of environments.

Within an instructional technology context, students could be asked to create environments that address real-world problems, such as global warming, political conflicts, social injustices, the COVID crisis, and cultural tensions due to hate crimes. Jigsaw learning activities are cooperative in nature (Huang et al., 2014) where multiple groups have the same material and each group member is assigned a different task to complete. The groups split up according to their assignments and form new groups in order to complete those tasks. Once the tasks are complete, everyone goes back to their original group to report the findings.

This type of learning activity can become even more challenging if the tasks involve the creation or analysis of specific virtual environments. For instance, four student groups could be assigned to read an article about XR. Four roles are assigned to each group member: find an app with AR, find a tutorial with VR, find a game or app with MR, and find an app or conceptual prototype of XR. Each role would correspond to something found in the article. After the roles are assigned, the groups match up with members of other groups according to their tasks. This assignment could go on for weeks, if needed, to give students time to explore XR in the classroom. When the tasks are complete, then the original groups come back together and discuss the article as well as how the examples they found address what is found in the article.

Wu et al. (2011) could extend the technological learning system they used in their study by including XR experiences, especially within the area of

AR. Having a language learning game or having students connect to each other in teams could have made the system more engaging. It is also possible to have students create games that incorporate an aspect of XR and have other students test those games (Guerreiro Farias et al., 2019; Kessler, 2019; Thompson, 2018). Students could decide to use an additional ubiquitous learning system with these suggestions. Yang et al. (2013) used The Poetry Multimedia Resource Index to help students find poetry according to their learning needs, and the suggestions presented by the learning system take into account more factors than what would be present with strictly paper-based methods. Wu et al. (2011) could be used to enhance this poetry indexing system. Searching indexes have been known to be useful to further learning goals, and there can be different contexts in how searches are described (Young Rieh et al., 2016).

CONCLUSION

So, is there more to XR than the pre-existing classifications of AR and VR? Based on the explanations we presented in this article, the answer is a resounding "yes!" There is so much potential for XR that the only real limitation is our mindset and imagination. For XR to grow and be more successful, more people will need to be open-minded about how it can be used. There is ample evidence that the technology can help with learning performance and understanding but there are challenges in implementing it. Not every company or university has the technology or accessibility to do this successfully. Cost, training, and space may be other obstacles to implementation but many of these challenges can be overcome. Improvements in the technology and wider availability of it that leads to lower cost hardware will continue so many of these issues will be addressed.

For any company, agency, or school considering using the technology, it would be beneficial to think about how context, authenticity, and experience play a role in digital expansions. As we argued here, situated learning theory can help with this. XR is a great tool for those who want to include aspects of culture in addition to real-world experiences and varied perspectives. In this respect, the universe, both real and virtual, truly can have more than two-sides after all.

REFERENCES

Brown, A. (1994). The advancement of learning. Educational Researcher, 23(8), 4–12. https://doi.org/10.3102/0013189X023008004

Bonasio, A. (2019). Immersive experiences in education: New places and spaces for learning [white paper]. Microsoft. https://edudownloads.azureedge.net/msdownloads/MicrosoftEducation_Immersive_Experiences_Education_2019.pdf

Cambridge Assessment English. (2019, March). Immersive gaming and English Language Learners. Webinar archived at https://www.youtube.com/watch?v=xVmdoXZmf18

Checa, D., & Bustillo, A. (2020). A review of immersive virtual reality serious games to enhance learning and training. Multimedia Tools and Applications, 79(9), 5501–5527. https://doi.org/10.1007/s11042-019-08348-9

Clinton, G., & Rieber, L. P. (2010). The studio experience at the University of Georgia: An example of constructionist learning for adults. Educational Technology Research & Development, 58, 755–780. https://doi.org/10.1007/s11423-010-9165-2

Coltekin, A., Lochhead, I., Madden, M., Christophe, S., Devaux, A., Pettit, C., Lock, O., Shukla, S., Herman, L., Stachon, Z., Kubicek, P., Snopkova, D., Bernardes, S., & Hedley, N. (2020). Extended reality in spatial sciences: A review of research challenges and future directions. ISPRS International Journal of Geo-Information, 9(7), 439. https://doi.org/10.3390/ijgi9070439

Donaldson, T., Fore, G. A., Filippelli, G. M., & Hess, J. L. (2020). A systematic review of the literature on situated learning in the geosciences: Beyond the classroom. International Journal of Science Education, 42(5), 722–743. https://doi.org/10.1080/09500693.2020.1727060

Durning, S. J., & Artino, A. R. (2011). Situativity theory: A perspective on how participants and the environment can interact: AMEE Guide no. 52. Medical Teacher, 33(3), 188–199. https://doi.org/10.3109/0142159X.2011.550965

Flynn, E. G., Laland, K. N., Kendal, R. L., Kendal, J. R. (2013). Target article with commentaries: Developmental niche construction. Developmental Science, 16(2), 296–313. https://doi.org/10.1111/desc.12030

Foucault, M. (1980). Power/knowledge: Selected interviews and other writings, 1972–1977 (Google Books Version). Pantheon Books. https://books.google.com/books/about/Power_Knowledge.html?id=Aqf309sk_EsC

Gessler, M. (2009). Situated learning and cognitive apprenticeship. In R. Maclean, D. Wilson (Eds.), International Handbook of Education for the Changing World of Work (pp.1611–1625). https://doi.org/10.1007/978-1-4020-5281-1_108

Gibson, J. J. (1978). The ecological approach to the visual perception of pictures. Leonardo, 11, 227–235. https://doi.org/10.2307/1574154

Goodman, G. (Ed.). (2010). Educational psychology reader: The art and science of how people learn. Peter Lang. https://doi.org/10.3726/978-1-4539-1279-9

Grey, T. (2012). Divine calling, organizational voice: A discursive study of “calling” and how it informs clergy organizational identity. The Journal of Adult Theological Education, 9(1), 44–60. https://doi.org/10.1179/ate.9.1.x6541n791g154j04

Guerreiro Farias, C. F., Harvey, S. Hastie, P. A., & Ribeiro Mesquita, I. M. (2019). Effects of situational constraints on students’ game-play development over three consecutive Sport Education seasons of invasion games. Physical Education and Sport Pedagogy, 24(3), 267–286. https://doi.org/10.1080/17408989.2019.1571184

Hamilton, D., McKechnie, J., Edgerton, E., & Wilson, C. (2021). Immersive virtual reality as a pedagogical tool in education: A systematic literature review of quantitative learning outcomes and experimental design. Journal of Computers in Education, 8(1), 1–32. https://doi.org/10.1007/s40692-020-00169-2

Huang, Y. M., Liao, Y. W., Huang, S. H., & Chen, H. C. (2014). A jigsaw-based cooperative learning approach to improve learning outcomes for mobile situated learning. Educational Technology & Society, 17(1), 128–140. https://www.jstor.org/stable/jeductechsoci.17.1.128

Hung, D. W. L., & Chen, D.-T. (2001). Situated cognition, Vygotskian thought and learning from the communities of practice perspective: Implications for the design of web-based e-learning. Educational Media International, 38(1), 3–12. https://doi.org/10.1080/09523980110037525

Hutchins, E. (2010). Cognitive ecology. Topics in Cognitive Science, 2(4), 705–715. https://doi.org/10.1111/j.1756-8765.2010.01089.x

ICRC Innovation Board. (2018). Extended reality—brief: Determining needs, expectations and the future of XR for the ICRC. https://blogs.icrc.org/inspired/wp-content/uploads/sites/107/2019/10/Extended-Reality-Report-BRIEF.pdf

Jabil. (2018). Trends in digital transformation: A survey of technology and business stakeholders in manufacturing companies January 2018. https://www.jabil.com/dam/jcr:41ad85b0-b74b-4004-807d-bc42b56c9e41/jabil-2018-digital-transformation-report.pdf

Jenkins, J. J., & Clarke, T. (2017). Engaged journalism: Using Experiential Learning Theory (ELT) for in-class journaling activities. International Journal of Teaching and Learning in Higher Education, 29(1), 154–161 (EJ1135973). ERIC. https://files.eric.ed.gov/fulltext/EJ1135973.pdf

Kessler, G. (2019, April 19). Augmented Reality for language learning. TESOL. http://blog.tesol.org/augmented-reality-for-language-learning/

Langer, P. (2009). Situated learning: Whatever happened to educational psychology? Educational Psychology Review, 21, 181–192. https://doi.org/10.1007/s10648-009-9099-6

Lave, J. (1988). Introduction: Psychology and Anthropology I. In Cognition in practice: Mind, mathematics, and culture in everyday life (pp. 1–10). Cambridge, MA: Cambridge University Press. http://www.beck-shop.de/fachbuch/leseprobe/9780521357340_Excerpt_001.pdf

Lubin, I., & Ge, X. (2012). Investigating the influences of a LEAPS model on preservice teachers' problem solving, metacognition, and motivation in an educational technology course. Educational Technology Research & Development, 60(2), 239–270. https://doi.org/10.1007/s11423-011-9224-3

Marr, B. (2019, August 12). What is extended reality technology? A simple explanation for anyone. Forbes. https://www.forbes.com/sites/bernardmarr/2019/08/12/what-is-extended-reality-technology-a-simple-explanation-for-anyone/

Marr, B. (2020, January 24). The 5 biggest virtual and augmented reality trends in 2020 everyone should know about. Forbes. https://www.forbes.com/sites/bernardmarr/2020/01/24/the-5-biggest-virtual-and-augmented-reality-trends-in-2020-everyone-should-know-about/?sh=55df254f24a8

Microsoft. (2020). Sales and service: A guide to building resilience. https://www.microsoft.com/en-us/resilience/sales-and-service-solutions

Moon, S., Kottur, S., Crook, P. A., De, A., Poddar, S., Levin, T., Whitney, D., Difranco, D., Beirami, A., Cho, E., Subba, R., & Geramifard, A. (2020). Situated and interactive multimodal conversations. Facebook. https://research.fb.com/wp-content/uploads/2020/12/Situated-and-Interactive-Multimodal-Conversations.pdf

Moore, J. L., Lin, X., Schwartz, D. L., Petrosino, A., Hickey D. T., Campbell, O., Hmelo, C., & The Cognition and Technology Group at Vanderbilt. (1994). The relationship between situated cognition and anchored instruction: A response to Tripp. Educational Technology, 34(8), 28–32. https://www.jstor.org/stable/44428227

Najjar, R. (2020, February 15). Extended Reality (XR) explained through the 5 + 1 senses. UX collective. https://uxdesign.cc/xr-through-5-1-senses-f396acf8a89f

Ord, J. (2012). John Dewey and experiential learning: Developing the theory of youth work. Youth & Policy, 108, 55–72. https://www.youthandpolicy.org/wp-content/uploads/2017/06/ord-yandp108.pdf

Orsmond, P., & Merry S. (2017). Tutors' assessment practices and students' situated learning in higher education: Chalk and cheese. Assessment & Evaluation in Higher Education, 42(2), 289–303. https://doi.org/10.1080/02602938.2015.1103366

Ortiz, A., & McGiffin, M. (2021). How Extended Reality will reshape commerce. https://www.3drobe.com/news/blog-post-one-gy63k

Pellas, N., Dengel, A., & Christopoulos, A. (2020). A scoping review of immersive virtual reality in STEM education. IEEE Transactions on Learning Technologies, 13(4), 748–761. https://doi.org/10.1109/TLT.2020.3019405

Raghavan, R., Rao, P., Rajgopalan, S., Welsh, J., & Voytko, M. (2018). Accenture Extended Reality (XR): Immersive learning for the future workforce. Accenture. https://www.accenture.com/_acnmedia/pdf-86/accenture-extended-reality-immersive-training.pdf

Schott, C., & Marshall, S. (2018). Virtual reality and situated experiential education: A conceptualization and exploratory trial. Journal of Computer Assisted Learning, 34(6), 843–852. https://doi.org/10.1111/jcal.12293

Scribani, J. (2019, January 16). What is Extended Reality (XR)? Visual Capitalist. https://www.visualcapitalist.com/extended-reality-xr/

Seaman, J., Brown, M., & Quay, J. (2017). The evolution of experiential learning theory: Tracing lines of research in the JEE. Journal of Experiential Education, 40(4), NP1–NP21. https://doi.org/10.1177/1053825916689268

Stewart, D., Westcott, K., & Cook, A. V. (2020, December 7). From virtual to reality: Digital reality headsets in enterprise and education, TMT Predictions 2021. Deloitte. https://www2.deloitte.com/xe/en/insights/industry/technology/technology-media-and-telecom-predictions/2021/vr-immersive-technologies.html/#/content/dam/insights/articles/US93838_TMT_Predictions_2021/DI_2021-TMT-predictions.pdf

Tata Consultancy Services (2020a). TCS global survey finds 90 percent of large enterprises are maintaining or increasing digital transformation budgets amid COVID 19. Cision PR Newswire. https://www.prnewswire.com/news-releases/tcs-global-survey-finds-90-of-large-enterprises-are-maintaining-or-increasing-digital-transformation-budgets-amid-covid-19-301140213.html

Tata Consultancy Services (2020b). Digital readiness and COVID-19: Assessing the impact. TCS.com. https://www.tcs.com/business-impact-survey-2020

Thompson, M. (2018). Making virtual reality a reality in today's classrooms. The Journal: Transforming Education Through Technology. https://thejournal.com/articles/2018/01/11/making-virtual-reality-a-reality-in-todays-classrooms.aspx

University of California, Berkeley (2021). Universal Design for Learning: Accessing virtual, augmented, and mixed realities. https://udl.berkeley.edu/accessibility/xr-accessibility/accessing-virtual-augmented-and-mixed-realities

van Dijk, H. W., & Voigt, E. H. (2012). Situational games: A white paper. http://www.mediafutureweek.nl/wp-content/uploads/2012/05/whitepaper-Situational-Games-NHL.pdf

Wendt, Z. (2020). Extended Reality explained: AR, VR & Mixed Reality technology. Arrow Electronics. https://www.arrow.com/en/research-and-events/articles/extended-reality-explained-ar-vr-and-mixed-reality-technology

Wu, T. T., Sung, T. W., Huang, Y. M., Yang, C. S., & Yang, J. T. (2011). Ubiquitous English Learning System with dynamic personalized guidance of learning portfolio. Educational Technology & Society, 14(4), 164–180. http://www.jstor.org/stable/jeductechsoci.14.4.164

Yang, C. C., Tseng, S. S., Liao, A. Y. H., & Liang, T. (2013). Situated poetry learning using multimedia resource sharing approach. Educational Technology & Society, 16(2), 282–295. https://www.jstor.org/stable/jeductechsoci.16.2.282

Young Reih, S., Collins-Thompson, K., Hansen, P., & Lee, H.-J. (2016). Towards searching as a learning process: A review of current perspectives and future directions. Journal of Information Science, 42(1), 19–34. https://doi.org/10.1177/0165551515615841