

learning, DAS has explored various technologies to build upon methods of architectural education, discourse, and exploration, finding several avenues in which the XR applications can be capitalize.

In light of the COVID-19 pandemic, XR technologies have also served as a tool to enable creative discourse between educators and students in the context of studio courses. Current uses of VR, AR, and MR, have connected students and institutions across the world, bringing design explorations and discussion to the digital forefront manifested by the social distancing of the pandemic. Furthermore, XRs widespread usage in academia is evident in multiple areas of study beyond design and architecture such as medicine, fine arts, and forensic science [16].

The growing adoption of XR is expanding, which prompts questions of additional methodologies and uses using VR, and AR with many possibilities currently appearing in uses of MR. MR as an extension of VR and AR proves to be invaluable in the AEC industry as a tool that can blend the virtual CAD model world with construction on site, while in real-time. While still in a phase of nascency, MR is being developed to improve methods of construction and ease coordination efforts in design projects. By being able to go beyond mere visualization and into serving as an aid to fabrication, MR paves the way for the implementation of future construction technologies. The usage of VR, AR, and MR as a robust pedagogical tool is an emerging practice within the realm of architecture; its adoption into the mainstream is favorable in many industries due to the efficacy of the medium to communicate, evaluate, and virtualize experience.

10. References

- [1] Christou, C. (2010). Virtual reality in education. *Affect. Interact. Cogn. Methods E-Learning Des. Creat. an Optim. Educ. Exp.*, no. February, pp. 228–243, DOI: 10.4018/978-1-60566-940-3.ch012.
- [2] Hui, V. Estrina, T. Zhou, G. Lee, S. and Kinuthia V. (2020). Architectural Accessibility and Pedagogy via Virtual Reality, in HUIC ASHE Conference Proceedings, pp. 1–13.
- [3] Estrina, T. and Hui, V. (2020). Extended Realities as Methods of Representation within Architectural Pedagogy.
- [4] Wang, P. Wu, P. Wang, J. Chi, H. L. and Wang, X. (2018). A critical review of the use of virtual reality in construction engineering education and training. *Int. J. Environ. Res. Public Health*. Vol. 15, no. 6, DOI: 10.3390/ijerph15061204.
- [5] Ruiz, R. Weghorst, S. Savage, J. Oppenheimer, P. Iii, T. F. and Dozal, Y. (2002). Virtual Reality for Archeological Maya Cities. UNESCO World Herit. Cent. Conf.
- [6] Ishii H. et al., (2002). Augmented urban planning workbench: Overlaying drawings, physical models and digital simulation,” *Proc. - Int. Symp. Mix. Augment. Reality, ISMAR-2002*, pp. 203–214. DOI: 10.1109/ISMAR.2002.1115090.
- [7] Jahn, G., Newnham, C., & van der Berg, N., & Iraheta, M. & Wells, J., (2019). *Holographic Construction*.
- [8] R. G. Alvarado and T. Maver, “Virtual Reality in Architectural Education: Defining Possibilities,” *ACADIA Q.*, vol. 18, no. 4, pp. 97–99, 1999, http://cumincad.scix.net/cgi-bin/works/Show?_id=4d95&sort=DEF AULT&search=virtualreality&hits=2442 (Access Date: 15 May 2021).
- [9] Mead, C. Buxner, S. Bruce, G. Taylor, W. Semken, S. and Anbar, A. D. (2019). Immersive, interactive virtual field trips promote science learning. *J. Geosci. Educ.*, vol. 67, no. 2, pp. 131–142, Apr. DOI: 10.1080/10899995.2019.1565285.
- [10] Adhanom, T. (2020). WHO Director-General’s opening remarks at the media briefing on COVID-19 (11 March 2020). World Health Organization. <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19-11-march-2020> (Access Date: 20 May 2021).
- [11] Hui, V. Townsend, S. Gantous, S. and McCarthy, G. (2013). *Arch App | An Application for Architectural Design Pedagogy*.
- [12] Hill, D. (2019). How Virtual Reality Impacts the Landscape Architecture Design Process at Various Scales, All Grad. Theses Diss. <https://digitalcommons.usu.edu/etd/7519> (Access Date: 12 April 2021).
- [13] Di Gironimo G. and Lanzotti, A. (2009). Designing in VR. *Int. J. Interact. Des. Manuf.*, Vol. 3, no. 2, pp. 51–53, , DOI: 10.1007/s12008-009-0068-6.
- [14] Hui, V., Compeau, M., Pu, K. and Arabian, T. (2013). Design In Hand | A Pedagogical Application Of Augmented Reality In Design Development, in INTED2013 Proceedings, pp. 5987–5996.
- [15] Jahn, G., Newnham, C., van den Berg, N. and Beanland, M. (2018). Making in Mixed Reality,” *Acadia*, January, pp. 88–97, http://papers.cumincad.org/cgi-bin/works/BrowseTreefield=seriesorder=AZ/Show?acadia18_88 (Access Date: 16 April 2021).
- [16] C. Tawhai, (2017). *Immersive 360° Video For Forensic Education*. Perth.