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XR and AI as disruptors in South African art and design education

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Abstract

This paper investigates the disruptive power of extended reality (XR) technologies, synergistically combined with artificial intelligence (AI), on creative art and design education in South Africa. Informed by an integrative literature review and insights derived from research conducted for the EU-funded Metaverse Academy Project with students and industry representatives, this study demonstrates how these technologies are altering established paradigms within artistic practice and design methodologies. Approached from an Actor-Network-Theory perspective and Social Disruptive Technologies framework, the analysis underscores the creation of new market opportunities for art and design professionals within the burgeoning XR industry, requiring the adaptation of traditional art and design curricula. Furthermore, the paper critically explores how virtual classrooms, powered by XR, are dismantling the spatial constraints of conventional educational settings, enabling innovative pedagogical approaches. The democratisation of access to education, however, remains fraught. By focusing on the transformative convergence of XR and AI, this research highlights the shift these technologies represent for the future of creative education in South Africa, emphasising the imperative for educators and institutions to embrace these advancements to equip students for a rapidly evolving creative economy.

Keywords: Extended reality (XR), artificial intelligence (AI), creative education, social disruptive technologies

Introduction

The use of emerging technologies in education has significantly increased since the COVID-19 pandemic, with artificial intelligence (AI) and extended reality (XR) enhancing learner-centred teaching (Rangel-de Lázaro & Duart 2023, p.1). In South Africa, AI adoption in higher education is rising due to its benefits for academic support, though obstacles persist (Mbangeleli & Funda 2024, p.165).

This paper approaches XR and AI as social disruptive technologies (SDTs) (Hopster 2021, p. 1) that can drive transformation in established systems (Madubela 2025). We explore the art and design education 'assemblage'—comprising educators, students, technologies, and learning environments—as a complex Actor-Network of human and non-human elements.

Though often viewed as positive disruptors, XR and AI face barriers such as curriculum integration challenges and educator–student skills gaps (Crolla *et al.* 2024, p.4).

This paper investigates the disruptive and transformative potential of these technologies by analysing their impact as part of the art and design Actor-Network. If adopted judiciously, XR and AI promise to engage a new generation of artists and designers while strengthening South Africa's creative economy.

Theoretical framework

Social disruptive technologies (SDTs)

There's a key distinction between **transformative** and **disruptive** technologies. Transformations occur gradually, while disruption is sudden, causing uncertainty before stakeholders can adapt (Hopster 2021, p. 5). Hopster argues that education systems must develop **proactive** strategies to anticipate these Social Disruptive Technologies (SDTs) rather than simply reacting to change.

However, Moravec and Martínez-Bravo (2023, p. 2) highlight that sudden disruptions often trigger broader societal transformations. They suggest the distinction isn't always clear-cut, as the slow response of conventional education systems creates a disconnect with industry and society. Therefore, the distinction between disruptive and transformational technologies depends on context and time.

Actor-network-theory and SDT theory

Actor-Network-Theory (ANT) is an approach from the social studies of science and technology, underpinned by a relational ontology (Kamp 2019, p. 1). From this perspective, technology holds symmetrical agency within socio-technical systems; all elements—institutions, software, educators, and learners—can exert force on one another, becoming what they are only within that specific relation (Mörtsell 2024, p. 322). Because these Actor-Networks are not fixed, it is crucial to anticipate technological impacts rather than simply reacting to change (Israeli *et al.* 2024, p. 178; Latour 1996, p. 2).

A key concept in ANT is the ‘mediator’, an entity—human or non-human—that actively transforms, translates, or reconfigures what it interacts with in a network. Unlike passive intermediaries, mediators are dynamic and unpredictable, transforming meaning or agency rather than just transporting it (Savransky 2020, p. 145). This gives mediators a creative role, ensuring outcomes are not predetermined but emerge from complex interactions. This framework emphasises the generative role of technologies in education, and the unpredictable nature of mediators can be likened to that of disruptive technologies. Having established this theoretical lens, the following discussion will detail extended reality (XR) and artificial intelligence (AI) as key technological actants, illustrating their disruptive potential.

Background on xr technologies as integrated with AI

Extended reality (XR) is an umbrella term for immersive technologies—including virtual reality (VR), augmented reality (AR), and mixed reality (MR)—that merge real and virtual worlds. These technologies are increasingly synergistic with artificial intelligence (AI), which functions as a co-creator that augments, rather than replaces, human creativity (Ivcevic 2024, p. 2). AI processes are now embedded in most high-end software for artists and designers (Czajka 2025).

VR provides a fully immersive digital experience, replacing a user’s physical surroundings with a simulated environment via a head-mounted display (HMD). As hardware becomes more accessible (Edstutia 2025), widespread VR adoption is increasingly feasible.

In contrast, AR enhances the real world by overlaying it with digital information, often via smartphones. It fosters interactive visualisations that can revolutionise design processes and has significant commercial and industrial applications (Huang 2024, p. 271; Jessen 2020; Cademix 2024; Metaverse Academy 2024b). MR is the most advanced form, creating interactive environments where physical and digital objects coexist. The software supporting these technologies evolves rapidly, with many options becoming quickly obsolete (Meccawy 2022).

Despite challenges, South African universities are implementing XR technologies, mainly in engineering, architecture, and the built environment. They utilise applications like virtual design labs, safety training simulations, and immersive architectural models to allow students to visualise complex structures and engage in practical prototyping (Tonga 2025, p. 1512).

Methodology

This study employs an explorative, integrative literature review, synthesising insights from Art and Design pedagogy, XR and AI technologies, and research from the EU-funded Metaverse Academy Project. The literature search was conducted in two stages. The first stage aimed to establish the relevant Actor-Network nodes within the art and design education system.

The second stage provided an overview of how XR technologies have transformed or disrupted these nodes. This was accomplished through desktop research guided by three open-ended questions exploring: a) New learning experiences and pedagogical models afforded by AI and XR. b) Key factors (pedagogical, technological, cultural, economic) influencing integration in diverse settings like South Africa. c) How these technologies might reshape artistic workflows and outcomes.

The findings are discussed in terms of the South African Art and Design Education Actor-Network. The analysis focuses specifically on how XR technologies function as a mediator in this network, meaning how they transform and potentially disrupt familiar processes.

Art and design education system as an actor-network

This paper positions XR technologies as central mediators within an Actor-Network, interacting with other nodes conceptualised as ‘knots’ in a web of connections (Meyer 2021, p. 142). Understanding these symmetrical relations clarifies how XR reshapes art and design education in South Africa, where AI-enhanced tools challenge the idea that agency lies only with humans (Meyer 2021, p. 140).

Inspired by Meyer’s (2021, p. 141) description of aesthetic education as a network where elements knot and become entangled to form quasi-objects and quasi-subjects, this paper takes a non-dualistic approach. Following Mörtsell's caution, the actors and actants within this network are clustered into "knots of activities" for analysis. We therefore conceptualise the art and design education system as a network of relations entangled with XR technologies. These key knots include (Figure 1): Teaching and Learning Environments, Educator Skills, Curricula and Teaching Practices; Learner Skills and Creative Processes; Institutions, Resources and Access; Industry Demands and Opportunities.

This conceptualisation as a dynamic Actor-Network, where human and non-human elements are intricately entangled, finds further resonance in Connectivism Learning Theory. Connectivism posits that knowledge is distributed across networks and learning occurs through forming connections between diverse 'nodes'—a perspective that aligns with how XR and AI mediate creative skills within this evolving landscape (Alam 2023).

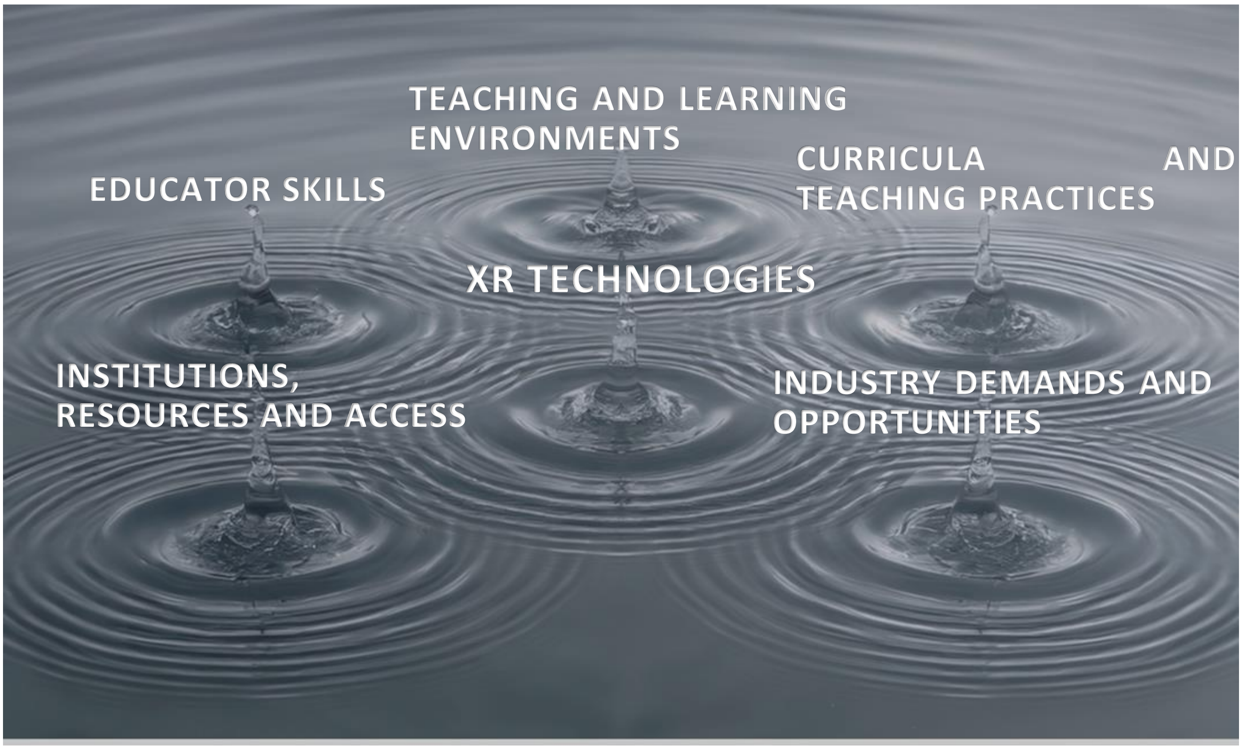

Figure 21: XR technologies as central mediator in art and design education network

Results and discussion

This analysis examines the intricate interplay between XR technologies and the various actors within the art and design education network. As previously conceptualised, these actors are clustered into dynamic knots of activities. The introduction of XR and AI as mediators actively reconfigures these entanglements, creating new relationships and disrupting established practices. The following discussion examines the impact on each of these interconnected knots, beginning with the transformation of teaching and learning environments.

Teaching and learning environments

The convergence of XR and AI is reshaping teaching and learning environments, blurring boundaries between the physical and digital. Students must now design and interact within responsive, data-rich spaces that require environmental sensing and interaction design skills (Critical Playground 2025). Virtual classrooms remove traditional spatial limits, enabling interactive experiences that maintain presence and connection.

These new environments foster enhanced engagement by immersing students in realistic simulations that make complex concepts tangible, which improves learning outcomes and knowledge retention (Shaukat 2023, p.56). Virtual and augmented environments promote active participation, empowering students to experiment and learn independently through inquiry-based discovery in controlled yet realistic scenarios (Berg & Toit-Brits 2023, p. 5). This can be further understood through Behavioral Reasoning Theory (BRT), where XR's immersive affordances serve as powerful facilitators, strengthening students' reasons for active participation (Tani *et al.* 2021). A study on XR in Landscape Architecture design found that students benefit from directing their own focus within a VR experience (Andalib and Monsur 2024, p. 22). They reported that engaging with their designs in a simulated real-world context provided better insight. VR therefore enhances spatial understanding, allowing students to inhabit their 3D creations (Serna-Mendiburu 2024, p. 3; Ruan 2022, p. 11).

In this context, XR and AI, as mediators, actively translate abstract concepts into engaging experiences and reconfigure the traditional boundaries of learning, fostering a dynamic interaction that reshapes pedagogical delivery.

Furthermore, virtual platforms can create a sense of shared presence and community, which is useful for fostering teamwork and communication skills. However, concerns remain regarding the replacement of face-to-face interaction, which is still valued (Kluge *et al.* 2022, p. 9). Personalisation is another key advantage, as AI-enabled XR environments can adapt to individual learning styles, delivering customized content that makes learning more inclusive and effective (Meccawy 2022, p. 12). The rise of hybrid and online models facilitates unprecedented access to tertiary education, but the digital divide and bandwidth limitations in South Africa (Mosupye-Semenya 2024, p. 5) require institutions to balance global connectivity with local relevance and inclusivity (Critical Playground 2025). This reconfiguration of the teaching environment inevitably creates tensions and demands for adaptation in the adjacent knot of educator skills and pedagogical practices.

Educator skills, curricula, and teaching practices

The shift towards technology-infused creative education requires an equivalent evolution in the skills and pedagogical approaches of educators. The traditional role of the educator as a master of specific knowledge is being disrupted; educators are now becoming bricoleurs (Matthews 2019, p. 424), understanding that a digital option is not always the most appropriate. For instance, the Andalib and Monsur (2024) study indicated that students valued combining XR technologies with more traditional methods. Educators must now facilitate critical inquiry and navigate the ethical dimensions of AI and XR. Here, these technologies act as crucial mediators, reconfiguring the educator's agency and practice by translating instructional roles into those of guides and collaborators, necessitating a profound adaptation of pedagogy and curriculum design.

This transition demands significant upskilling. A baseline of technological proficiency is essential for educators to critically assess the potential and limitations of XR and AI tools within a pedagogical context (Dooley *et al.* 2024, p.337). This technical awareness must be paired with pedagogical innovation, requiring educators to design new immersive and experiential lessons. From a constructivist perspective, XR environments enable learners to construct their own understanding through situated interaction with virtual artefacts (Andalib & Monsur 2024, 157). In design education, MR environments stimulate personal engagement by providing multisensory 3D interactions, facilitating collaborative design sessions, and enhancing prototyping with a tangible sense of presence (Liu 2024, P4).

Contemporary art and design curricula must now include topics like prompt engineering for generative AI, the principles of dataset ethics to mitigate bias, and the importance of model transparency (Critical Playground 2025). Educators should guide students in critiquing machine-made work and engage them in discussions on the complex ethical dilemmas posed by these technologies. An interdisciplinary approach connecting art, design, interaction design, and ethics is fundamental (Critical Playground 2025).

Central to this evolution is adopting a non-determinist approach to technology. Educators must impart the understanding that a technology's impact is shaped by the social, cultural, and pedagogical relationships within the educational network (Matthews 2019, p. 415). Faculty development programs that provide professional training and encourage experimentation are crucial for equipping educators to optimize these technologies for pedagogical purposes (Keynes *et al.* 2022, p. 9). Courses must strike a balance between cultivating digital competencies and nurturing fundamental analogue skills and spatial intelligence (Chandrasekera & Yoon 2018, p. 57). Finally, AI-powered platforms can offer personalised learning pathways, freeing educators to focus on mentorship and higher-order critical thinking skills (Hutson 2023).

Learner skills and creative processes

As educational and industry landscapes evolve, the required skill set for the art and design learner must also transform. A Metaverse Academy report suggests that South African students have a significant deficit in XR awareness and skills compared to their European counterparts (Metaverse-Academy Project Consortium 2024). Preparing for careers in the creative industries now demands a hybrid blend of technical, creative, and critical competencies.

While foundational artistic talent remains essential, it is no longer sufficient. A significant emphasis is now placed on technical skills, including proficiency in 3D modelling, 3D photography, animation, and creating immersive content for XR platforms. Simultaneously, fluency with AI-driven design tools is becoming a prerequisite for ideation, iteration, and production (Dooley *et al.* 2024 p. 338; Mendoza-Garcia *et al.* 2024, p. 4). Beyond mere technical operation, learners must develop a deeper conceptual understanding, learning how to interact with intelligent systems as creative partners rather than passive users.

This technical proficiency must be complemented by a robust suite of critical and soft skills. Interventions such as the EU-funded Metaverse Academy MOOC platform, which will become available in December 2025, are addressing this need for student skills development (Metaverse-Academy Project Consortium 2025; Mosupye-Semenya 2024, p. 6). As designers increasingly curate AI-generated content, the capacity for critical evaluation becomes a core competency. Essential soft skills like communication, collaboration, and resilience are vital for interdisciplinary, team-based projects often managed across virtual platforms (Dooley *et al.* 2024, p. 339).

Amidst this digital transformation, there is a growing concern about the potential erosion of traditional analogue design abilities and spatial intelligence due to an over-reliance on digital tools, highlighting the need for a balanced education (Mendoza-Garcia *et al.* 2024). Finally, ethical awareness is a non-negotiable skill, requiring students to critically assess the societal impact of XR and AI, including complex issues of authorship, algorithmic bias, and digital equity.

Institutions, resources and access

While extended reality (XR) technologies are being integrated into curricula worldwide, in South Africa, the process is fraught with challenges reflecting broader socio-economic disparities. The primary obstacle remains the prohibitive cost of acquiring and maintaining high-end hardware and software, a financial burden particularly challenging for less-resourced institutions (Meccawy 2022, p. 4). This is exacerbated by a historical tendency in South African higher education not to prioritize funding for new technologies (Ohei *et al.* 2023, p. 291), risking a deepening of the existing digital divide.

Furthermore, there is a critical need for cultural and contextual relevance. For XR to be effective, research underscores that it must resonate with the lived experiences of South African students (Mawere *et al.* 2021, p. 46). This has led to a strong recommendation for developing localised content—virtual environments and simulations reflecting local landscapes and cultures—to enhance student engagement (Mosupye-Semenya 2024, p. 6).

Collaborations among South African universities, global counterparts, and the private sector are vital for sharing resources and applying international best practices (Gudyanga 2024, p. 236; Meisner 2019, p. 1358; La Cruz, Rabetino & Kantola 2022, p. 1380).

A promising hands-on approach is creating sponsored incubators linked to internships, as developed by the Metaverse Academy, which can become hubs for co-creating content. Simultaneously, a powerful avenue for democratising access is leveraging mobile technology. With 99% of South African internet users accessing it via smartphones (McInnes 2025), and institutions like Nelson Mandela University already implementing simplified mobile VR content (Tonga 2025, p. 1514), educators can deploy mobile augmented reality (AR) to extend learning beyond campus. However, unstable electricity and network connectivity remain problematic. To truly unlock XR's potential, institutions must also fund faculty development initiatives to ensure pedagogically sound and contextually appropriate integration (Wang, Young, Iqbal & Guckin 2023, p. 9004).

Industry demands and opportunities

The synergistic rise of XR and AI is a disruptive force in the creative industries, dismantling old job roles while simultaneously creating a host of new market opportunities (De Klerk *et al.* 2024). This wave reshapes industry demands, valuing professionals who combine artistic vision with technological skills. This has economic implications globally, with significant potential for growth and job creation in nations like South Africa. The Metaverse Academy Market Research Report highlights the growing market for XR training materials, digital twin development, VR and AR marketing and countless other still unknown XR solutions for a wide range of industries in South Africa and Europe (Metaverse-Academy-Project Consortium 2024). The very nature of creative work is being redefined, leading to the emergence of entirely new career paths. AI-driven art creation, where artists collaborate with generative algorithms like Generative Adversarial Networks (GANs) to explore previously unimaginable creative territories, functioning as both artists and AI technologists (Monser 2023, p. 78) is becoming a common practice. In parallel, the demand for talent in XR design is exploding. The burgeoning XR market requires skilled visual storytellers, UX/UI designers for spatial interfaces, interactive experience creators, and immersive content developers who can build the engaging, spatially-aware worlds that these platforms promise (Kim 2025, p. 1430).

This transformation extends the advertising and marketing industries, with AI tools enabling hyper-personalised, data-driven campaigns and XR providing new avenues for immersive and even embodied storytelling (Scholz & Duffy 2018, p. 17) and brand engagement, creating roles that blend creativity with strategic data analysis. The educational sector itself presents a growing job market for educators and instructional technologists who can design and deliver the innovative curricula that these new technologies demand (Jin & Tiejun 2023). For a country like South Africa, harnessing these opportunities could be transformative. The integration of XR and AI can stimulate economic growth across key sectors. In tourism, immersive XR experiences can highlight cultural heritage in new ways, while AI analytics can optimise marketing strategies to attract visitors and boost local economies (Markopoulos *et al.* 2021, p. 2). For the critical SME sector, XR tools can provide affordable ways to create virtual showcases and expand market reach, while AI offers powerful insights for improving operational efficiency (Tirivangasi 2018). Furthermore, these technologies can be pivotal in advancing the green economy and empowering youth and women with the high-demand ICT skills necessary to thrive in the digital economy (Otieno & Ochieng 2018, p. 1; Ohei & Mantzaris 2023, p. 289).

Conclusions and recommendations

From an Actor-Network Theory (ANT) perspective, this paper has framed extended reality (XR) technologies not as neutral tools, but as potent mediators actively disrupting the South African art and design education system. This disruption is a complex, relational process that unfolds across the entire educational assemblage.

The disruption manifests in a rapid transformation of established roles, forcing educators to become facilitators of technological and ethical inquiry, while learners must cultivate a hybrid skillset blending creative, technical, and critical competencies. Curricula evolve in response to industry's adoption of XR, while learning environments are redefined across physical and virtual spaces. However, in mediating these changes, XR also amplifies pre-existing South African challenges, including the digital divide, socio-economic disparity, and the prohibitive cost of access, creating significant barriers to equitable integration. Harnessing these disruptions requires a context-aware approach balancing technology adoption with localised content, inclusive access, and educator–learner support.

This study is primarily a qualitative, non-systematic literature-based exploration and does not include empirical observations from case studies. Its broad scope, while useful for mapping the general Actor-Network, means that specific nuances within different institutions or creative disciplines may be overlooked. Some network complexities were also simplified due to space constraints.

Future research should address these gaps through empirical studies, such as case studies of XR implementation in South African art and design faculties, to gather direct observations. Longitudinal studies would be particularly valuable for tracking the long-term impacts of this disruption on student learning outcomes and career trajectories. Further investigation is also needed into developing culturally relevant, localised XR content and pedagogical models that effectively address South Africa's unique socio-economic context. Finally, exploring the policy and institutional strategies required to support an equitable and effective integration of XR is essential for these technologies to reach their full potential.

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