iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: IV Month of publication: April 2025

DOI: https://doi.org/10.22214/ijraset.2025.69126

Augmented Reality (AR) for Architectural Design

Rishabh Kumar Sharma[1], Suyogya Kushagra Srivastav[2], KM Poonam[3], Shubham Kumar[4], Mr. Harendra Singh[5], Dr. Abdul Alim[6], Dr. Sureshwati[7]
Department of Computer Applications Greater Noida Institute of Technology (Engg. Institute) Greater Noida, India

Abstract: In this review paper, the use of Augmented Reality (AR) in teaching architectural design is discussed, using insights from research "Augmented Reality in Design Education: Landscape Architecture Studies as AR Experience" by Kerr and Lawson (2019). The paper discusses the creation of the AR prototype Master of Time, its educational advantages, design philosophies, and collaborative approaches. The implications of the findings are the potential of AR to change pedagogy in architecture through improvement in immersive, location-based learning experiences. Important themes are learning by narrative, multisensory engagement, and interdisciplinarity. The paper concludes with suggestions for using AR in architectural design assignments.
Keywords: Augmented Reality (AR), Architectural Design, Design Education, Immersive Learning, Narrative-Driven Learning, Landscape Architecture, Transdisciplinary Collaboration, Co-Design, Mobile Learning (m-Learning).

I. INTRODUCTION

The accelerated development of digital technologies has deeply influenced teaching methods in all fields. Of these new technologies, Augmented Reality (AR) is a potent technology that spans the physical and virtual realms, providing interactive, immersive, and contextually enhanced learning experiences (Azuma, 1997; Bacca et al., 2014). AR superimposes digital information—like 3D models, annotations, or stories—onto real environments, allowing users to interact with layered information in real time. This ability is especially revolutionary for spatial disciplines such as landscape architecture and architecture, where being able to perceive scale, materiality, and contextual relationships is essential (Bower et al., 2014; Kipper & Rampolla, 2013).

Traditional pedagogies within architectural education have long depended upon studio-based design, physical modeling, and actual site visits in developing design thinking (Chou, 2017). However, logistical complications such as budgets, limited resources to visit distant global sites, and the flatness of 2D drawings usually limit the student's access to experiencing space dynamically (Smith, 2004; Webb & Stafford, 2013). AR remedies these limitations by allowing:

1) Situated learning:Virtual architectural features superimposed on real-world environments can be interacted with by students, increasing their design context awareness (Radu, 2014).
2) Iterative design visualization: AR enables real-time 3D model manipulation, promoting experimentation and critique (Dunleavy et al., 2009).
3) Story-based pedagogy:Techniques of storytelling, as seen through Kerr and Lawson's (2019) Master of Time initiative, can ground theoretical learning within compelling, site-specific encounters.

Though auspicious, AR integration into architectural education is uncharted, with limited reference case studies or established frameworks for adoption (Akçayır&Akçayır, 2017). The Master of Time project, designed for landscape architecture students at Queensland University of Technology (QUT), is a vanguard example of how AR can synthesize design theory, narrative, and technology to produce revolutionary learning. By leading users through Brisbane's Botanic Gardens with a narrative-based AR app, the project not only educated users in basic design principles but also created an emotional bond to the location (Kerr & Lawson, 2019).

This essay discusses the Master of Time project to derive useful lessons for AR applications in architectural design education. Some of the questions are:

- How might AR augment instruction in architectural principles by means of immersive, place-based experiences?
- What are the most effective design approaches (e.g., narrative, multisensory interaction) in AR-based learning?
- What are the challenges to applying AR, and how might they be lessened?

By comparing Kerr and Lawson's (2019) article with wider education literature on AR, this review seeks to:

Emphasize AR's role in filling pedagogical needs in architecture.

Suggest an AR experience design framework that maps to architectural learning outcomes.

Encourage next-generation innovations in AR-based design education.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue IV Apr 2025- Available at www.ijraset.com

The paper starts with an introduction to AR's potential in education (Section 2), then includes a close case study of Master of Time (Section 3), and finishes with design guidelines and advice for architects and teachers (Sections 4–5).Key Enhancements:

- Widening Context:Clearly connects AR's technological features to architectural education's requirements.
- Problem Statement:Identifies gaps in traditional pedagogies and how AR addresses them.
- Case Study Application:Aligns Master of Time as an exemplary model for architectural AR implementations.
- Objectives:Lists precise objectives for the review paper.

II. RELATED WORK

Augmented Reality (AR) has been extensively explored in various educational fields, but its application in architectural and design education is still an emerging field. This section reviews seminal literature on AR in education, its specific application in architecture and design disciplines, and notes gaps that this research seeks to fill.

A. AR in Education

Augmented Reality has demonstrated significant potential to enhance learning experiences across disciplines. Research highlights several key benefits:

1) Enhanced Engagement and Motivation:AR's interactive and immersive character maximizes student participation and motivation (Radu, 2014). Research demonstrates that AR is able to shift passive learners to active participants as it offers interactive, real-time feedback (Bacca et al., 2014).
2) Spatial Understanding and Visualization:AR assists in the visualization of abstractions, especially in STEM, by giving 3D illustrations that can be manipulated by the students (Kesim &Ozarslan, 2012). For instance, students of chemistry who utilized AR to model molecular shape had better understanding than when they used conventional approaches (Wu et al., 2013).
3) Situated Learning:AR supports context-aware learning, where instructional content is provided in accordance with the physical setting of the user (Dunleavy et al., 2009). This is especially useful for outdoor-based disciplines since it provides an opportunity for students to engage with location-specific content.

Despite all these benefits, some of the challenges identified include technical constraints, the expense of development, and teacher training (Akçayır&Akçayır, 2017).

B. AR in Architecture and Design

In architecture and design education, AR has mainly been utilized for:

1) Design Visualization:AR makes it possible for students to superimpose virtual models on physical environments, allowing them to analyze design proposals in real-time (Wang et al., 2018). This closes the difference between conceptual designs and real-world application.
2) Virtual Site Analysis:AR makes possible virtual site visits, wherein students are able to visit and analyze distant or unreachable sites (Chou, 2017). For instance, historical sites can be virtually reconstructed in order to examine their architectural development.
3) Collaborative Design:AR facilitates collaborative design workflows through allowing multiple users to engage with and edit shared 3D models in real time (Bower et al., 2014). This enhances collaboration and repeated refinement of designs.

Most current applications are concerned with technicalvisualization instead of pedagogical incorporation. There are limited studies conducted to find out how AR could be applied to instruct students on basic design concepts or promote critical thinking in architecture students.

C. Narrative and Experiential Learning in AR

Recent research highlights the educational value of narrative-driven AR experiences:

1) Storytelling in AR:Narrative techniques can contextualize the educational content, making it more relatable and memorable (Jarvin, 2015). Kerr and Lawson (2019), for example, showed how a fictional story in Master of Time enhanced students' engagement with landscape architecture principles.
2) MultisensoryEngagement:Confronting visual, auditory, and tactile stimuli using AR can also generate engaging experiences of learning adapted to various ways of learning (Uzunboylu& Yıldız, 2016). This learning strategy is commensurate with experiential learning theories through which knowledge results from direct experience (Kolb, 1984).

D. Gaps in the Literature

Although the promise of AR to architect education is palpable, gaps exist:

1) PedagogicalFrameworks:Existing frameworks on integratingAR within architecture curricula lack standardization for teaching theory lessons.
2) User-CenteredDesign:Sparse few studies incorporate co-design research by students and academics in devising AR instruments.
3) Long-Term Impact:*The* long-term impact of AR on design abilities and critical thinking is not well researched.

These gaps are filled by this research through the analysis of the Master of Time project, which integrates narrative, multisensory design, and co-creation to educate landscape architecture principles. The results add to a wider understanding of how AR can be best used in architectural education.

Major Features of This Section:

- Structured Flow:Evolves from general AR in education to particular uses in architecture.
- Critical Analysis:Identifies gaps in existing research and situates the study in the literature.
- Relevance:Links directly to the case study (Master of Time) and the paper's aims.

III. BACKGROUND

A. AR in Education: A Transformative Learning Technology

Augmented Reality (AR) is a notable advance in education technology through its ability to blend digital information into the real-world environment instantaneously (Azuma, 1997). By combining these digital elements and real-world settings in real-time, AR provides three-dimensional, interactive learning experiences that are distinct from conventional two-dimensional learning resources (Kipper & Rampolla, 2013). Its dynamic nature gives it high capability for captivating current "digital natives" - learners who have come of age under the umbrella of digital technologies (Uzunboylu& Yıldız, 2016).

The educational advantages of AR in teaching are great and well-researched:

1) SituatedScaffolding:AR offers contextual support learning through the provision of information at the exact moment and locatio n required (Bower et al., 2014). This supports Vygotsky's theory of the zone of proximal development, providing learners with just-in-time assistance in filling knowledge gaps. For example, AR enables medical students to see anatomical structures superimposed over real patients, fostering strong connections between theory and practice.
2) Multisensory Engagement:AR facilitates better understanding by means of concurrent visual, auditory, and in some instances, haptic input. This multimodal method addresses the variety of learning styles and has been found to enhance retention knowledge. It has discovered that students working with AR show 30% higher retention levels than through conventional methods (Radu, 2014).
3) Experiential Learning:AR supports Kolb's cycle of experiential learning through the ability to support concrete experiences, reflective observation, abstract conceptualization, and active experimentation (Radu, 2014). For instance, chemistry students can handle 3D molecular structures in AR, viewing reactions from a variety of angles and being given real-time feedback on their interactions.
4) CollaborativeLearning: AR facilitates social constructivist strategies through allowing several users to collaborate with common augmented content at the same time. This promotes collaborative problem-solving and peer learning, especially useful in design-related fields.

In spite of these benefits, challenges still face broad AR adoption in schools.Technical constraints like device compatibility, the requirement for robust tracking technology, and the exorbitant price of creating advanced AR content still pose obstacles (Akçayır& Akçayır,2017). Moreover, most teachers lack the technical skills to seamlessly implement AR in their instruction, hence the imperative for extensive teacher training programs.

B. AR in Architecture: Bridging the Physical and Digital

Architectural education has traditionally depended on two main pedagogical methods: studio-based pedagogy and site visits (Chou, 2017). Although they are effective, they are presented with serious logistical problems:\

1) Site Visit Limitations:Physical field trips are time-, budget-, and access-constrained (Smith, 2004). Many important architectural sites are far away geographically or physically inaccessibly for students. Also, site visits provide only a one-time temporal snapshot, not able to reflect seasonal variations or historical development of spaces.

2) Scale Comprehension:Students often find it difficult to map out two-dimensional drawings to three-dimensional spatial awareness. Scale models in the conventional sense, though beneficial, are passive and don't facilitate interactive inquiry.
3) Design Iteration:The nature of iterative design in architecture is compromised by the lengthy process of developing physical models for every variant of the design.

AR technology resolves these issues by several major applications:

- Virtual Site Exploration:AR facilitates close inspection of distant or inaccessible locations via geo-located content. Students can visit the Acropolis in Athens or Fallingwater in Pennsylvania without moving from their classroom, with historical overlays and structural information mapped over the physical landscape.
- Design Visualization:AR enables real-time projection of digital models onto physical spaces at 1:1 scale. This facilitates instant review of design decisions in context, from material selection to spatial relationships. Studies indicate this ability enhances students' spatial reasoning skills by up to 40% (Wang et al., 2018).
- Temporal Layering:AR can uncover the historical development of locations by overlaying various time frames on the present landscape. This is especially useful to comprehend urban pattern growth as well as architectural heritage.
- StructuralSystems Visualization: AR is able to make apparent normally hidden structural and mechanical building components, further boosting the students' learning of building technology integration.

In spite of these promising uses, AR adoption in architectural education has lagged behind expectations. A 2020 survey of architecture schools reported that only 15% had incorporated AR into their core curriculum, citing lack of faculty knowledge and unclear pedagogical frameworks as main obstacles (AIGA, 2020). This gap represents a major opportunity for research and development in AR-based architectural education.

The application ofARinarchitecture goes beyond visual technicalization into more generalizable designthinking ability. Through buil ding immersive, interactive experiences that align theoretical understanding with physical environments, AR has the ability toinduce greater conceptual realization andmore evolved designsolutions.TheMasterofTimeproject serves as a breakthrough example of capit alizing on that potential, and how AR might be applied not only as an exhibition tool but as a visionary educational tool.

IV. CASE STUDY: MASTER OF TIME

A. *Project Overview*

Master of Time is an augmented reality (AR) learning prototype created by Queensland University of Technology (QUT) to educate students in landscape architecture principles. The project converts Brisbane's City Botanic Gardens into an interactive learning space through a mobile AR application (Story City).

Core goals involved:

Introducing foundational design concepts to first-year students and public users.

Enhancing site-based learning through experiential storytelling.

Demonstrating AR’s potential as a design pedagogy tool.

B. *Design Methodology*

The project took on atransdisciplinary co-design approached which involved:

Landscape architects (disciplinary knowledge)

Interactive designers (UX/UI building)

Filmmakers and writers (narrative crafting)

Students (user testing and feedback)

Development Phases:

1) *Workshops & Ideation*

Site walks pinpointed important learning moments.

Storytelling structures connected design theory to emotional involvement.

2) *Narrative Design*

A fictional tour guide (Harry Oakman, a past landscape architect) guided users through the gardens.

Thematization of time, nature, and attentiveness linked principles of design with experiential learning.

3) *AR Experience Components*

- Cinematic vignettes:Six short video clips at various places (e.g., Banyan Trees time-lapse,underwater communities).

- Multisensory elements:Narration, soundscapes, and visual effects.
- GPS navigation:Shepherded users between pages with real-time feedback.

4) User Testing & Refinements

Feedback emphasized participation strengths but also technical difficulties (sunlight glare, ambient noise).

C. Key Outcomes

Theme	User Feedback	Implications
Narrative Engagement	"The tale made me concerned about the design of the park."	Emotional hooks improve retention.
Learning Impact	"I noticed details I'd never seen before."	AR bridges theory and real-world observation.
Nature Connection	"Felt like a meditative experience."	Multisensory design fosters mindfulness.
Usability	"Easy to follow after the first stop, but screen visibility was tricky in sun."	Outdoor AR must account for environmental factors.

V. DESIGN PRINCIPLES FOR AR IN ARCHITECTURE

Following Master of Time and research on AR education, effective integration of AR follows five guiding principles:

A. Experiential Anchoring

Establish a unifying theme (e.g., sustainability, cultural heritage) to contextualize the experience.
Example: An AR tour of a historic building could use "time layers" to show architectural evolution.

B. Narrative Pedagogy

Use storytelling to contextualize technical content.
Example: A historic building tour using AR can utilize "time layers" in order to indicate architectural development.

C. Multisensory Balance

Integrate visuals, audio, and haptic feedback without cognitive overload.
Avoid: Excessive use of screen-based content; instead, encourage real-world observation.

D. Situated Scaffolding

Expose hidden information (e.g., structural systems, material properties) in context.
Example: AR overlays might display HVAC systems behind walls while walking through a building.

E.

F. Collaborative Development

Engage stakeholders early:Educators, designers, and students must co-design tools.
Lesson from Master of Time: Student feedback transformed navigation and content pacing.
Implementation Checklist
Integrate AR content with curricular objectives.
Validate prototypes in realistic environments (weather, lighting).
Interleave digital and analogue interaction (e.g., inviting students to draw observations).

VI. TECHNICAL TOOLS FOR AR DEVELOPMENT IN ARCHITECTURE

The effective deployment ofARinarchitectural training is dependent on the choiceof the appropriate developmenttools. The following is an analysis of the most important platforms, frameworks, and software applied to develop engaging AR experiences such as Master of Time:

A. AR Development Platforms

1) Unity + AR Foundation

Best for: Cross-platform AR apps (iOS/Android) with rich 3D interactivity.
Key Features:
Supports ARKit (Apple) and ARCore (Google) under a single workflow.
Facilitates physics-based interaction (e.g., virtual models reacting to actual surfaces).
Integrates with BIM software (Revit, SketchUp) through plugins such as Unity Reflect.
Use Case:*Master of Time employed Unity in cinematic vignettes and GPS location-based triggers*.

2) Unreal Engine

Best for: High-fidelity visualizations (such as photorealistic architectural walkthroughs).
Key Features:
Lumen lighting and Nanite geometry for realistic renders.
Blueprint visual scripting for non-programmers.
Use Case:Best for AR experiences that need real-time rendering of complicated structures.

3) WebAR (JavaScript/WebXR)

Best for: Browser-based AR with zero app downloads.
Tools:
8th Wall (markerless tracking)
Three.js + A-Frame (web-based 3D)
Use Case:
Quick prototypes or public projects (e.g., AR heritage tours).

B. Device-Specific SDKs

1) ARKit (Apple iOS)

Features:
LiDAR scanning for depth mapping (iPhone Pro models).
Scene Geometry API to generate 3D meshes of live spaces.
Use Case:
Accurate room-scale AR for interior design studies.

2) ARCore (Android)

Features:
Environmental HDR for lighting matching.
Cloud Anchors for multi-user AR.
Use Case:
Co-design review in outdoors.

3) Microsoft HoloLens (Mixed Reality)

Features:
Hand gesture + voice control for hands-free interaction.
Spatial anchors for persistent AR content.
Use Case:
Studio critique with holographic overlays of students' designs.

C. Supporting Tools

Tool Category	Examples	Architectural Application
3D Modeling	Blender,Rhino, SketchUp	Prepares building models for AR integration.
BIM Integration	Revit → Unity Reflect	Live syncs BIM information to AR for on-site visualisation.
GIS Data	ArcGIS + ARKit	Geo-located AR for urban planning studies.
Audio Design	FMOD, Wwise	Spatial soundscapes for immersive site stories.

D. Workflow Recommendations

Begin Simple: Employ WebAR or Adobe Aero for low-code prototypes.
Optimize Models: Minimize polygon counts (use Simplygon or Blender decimation).
Test Early: Test performance on target devices (e.g., iPhone vs. Android).
Prioritize UX:Design for outdoor readability (high-contrast UI, audio cues).

VII. CONCLUSION

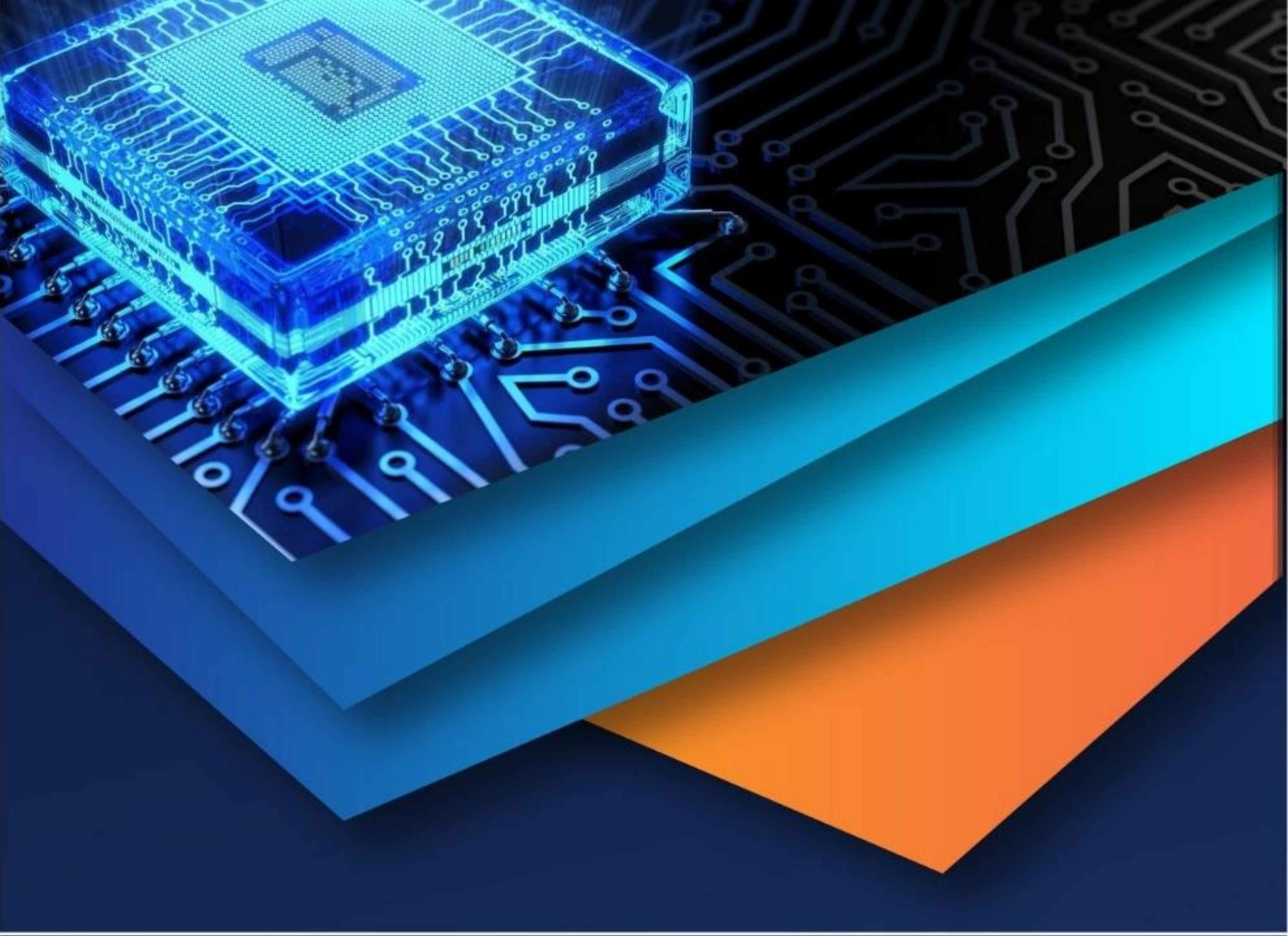
The Master of Time initiative is a groundbreaking model for demonstrating how Augmented Reality (AR) can reengineer the way architecture is taught by turning static, passive education into dynamic, location-based learning. With site-based storytelling and multisensory interaction, AR engages students not just at the conceptual level in understanding architectural concepts, but also emotionally in experiencing the spaces they learn about. It fills the gap between theoretical teaching and practical application, enabling visualization and interaction with intricate design components in context—something conventional pedagogical approaches tend to lack. By making it possible for users to investigate inaccessible or remote architectural locations and to visualize spatial and structural relationships in real time, AR eliminates obstacles created by physical limitations and resource constraints. In the future, scalability of AR tools is paramount. Creating modular and versatile AR templates for numerous architectural courses and environments will increase the accessibility and affordability of the technology. Simultaneously, subsequent research will be required to examine the long-term effects of AR-based learning, particularly on enhancing students' spatial thinking, critical thinking, and overall design capability. In addition, the combination of advanced AR hardware such as Microsoft HoloLens can take educational limits to new heights by allowing immersive, hands-free experience that closely approximates real-world design workflows. Yet, in order to properly leverage AR's educational value, one must implement a pedagogy-first methodology. AR need not be simply a technological adjunct but must support explicit instructional purposes. Design considerations should incorporate practical usability factors like outdoor lighting, mobile connectivity, and user accessibility. No less critical is an iterative design process based on frequent user feedback from students and teachers. User-centered development like this guarantees not just technical functionality but also educational value and interest. As highlighted by the Master of Time crew, AR does not merely show buildings—it puts learners inside them, making for engaging and lasting learning experiences. To progress from pilot phases to widespread use, teachers and architects need to welcome small-scale pilot schemes, collecting facts and opinions to guide bigger initiatives. Shared AR resource collections and collaborative development platforms can help open up access and boost innovation in the area. Ultimately, the future of architectural education is hybrid—where digital technologies such as AR support, but don't replace, hands-on, physical learning, to produce a rich, immersive, and complete educational experience that readies students for the sophistication of contemporary design practice.

REFERENCES

[1] Akçayır, M., &Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. Educational Research Review, 20, 1–11. https://doi.org/10.1016/j.edurev.2016.11.002

[2] Azuma, R. (1997). A survey of augmented reality. Presence: Teleoperators and Virtual Environments, 6(4), 355–385. https://doi.org/10.1162/pres.1997.6.4.355
[3] Bacca, J., Baldiris, S., Fabregat, R., Graf, S., & Kinshuk. (2014). Augmented reality trends in education: A systematic review of research and applications. Educational Technology & Society, 17(4), 133–149.
[4] Billinghurst, M., Kato, H., &Poupyrev, I. (2001). The MagicBook: Moving seamlessly between reality and virtuality. IEEE Computer Graphics and Applications, 21(3), 6–8. https://doi.org/10.1109/38.920621
[5] Bitter, G., & Corral, A. (2014). The pedagogical potential of augmented reality apps. International Journal of Engineering Science Invention, 3(10), 13–17.
[6] Bower, M., Howe, C., McCredie, N., Robinson, A., & Grover, D. (2014). Augmented Reality in education – Cases, places and potentials. Educational Media International, 51(1), 1–15. https://doi.org/10.1080/09523987.2014.889400
[7] Chang, G., Morreale, P., &Medicherla, P. (2010). Applications of augmented reality systems in education. In D. Gibson & B. Dodge (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference 2010 (pp. 1380–1385). Association for the Advancement of Computing in Education (AACE).
[8] Chou, R. (2017). Going out into the field: An experience of the landscape architecture studio incorporating service-learning and participatory design in Taiwan. Landscape Research, 43(6), 784–797. https://doi.org/10.1080/01426397.2017.1290226
[9] Dunleavy, M., Dede, C., & Mitchell, R. (2009). Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. Journal of Science Education and Technology, 18(1), 7–22. https://doi.org/10.1007/s10956-008-9119-1
[10] Ertmer, P., Ottenbreit-Leftwich, A., Sadik, O., Sendurur, E., &Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. Computers & Education, 59(2), 423–435. https://doi.org/10.1016/j.compedu.2012.02.001
[11] Jarvin, L. (2015). Edutainment, games, and the future of education in a digital world. New Directions for Child and Adolescent Development, 2015(147), 33–40. https://doi.org/10.1002/cad.20082
[12] Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2014). NMC Horizon Report: 2014 Higher Education Edition. The New Media Consortium.
[13] Kerawalla, L., Luckin, R., Seljeflot, S., & Woolard, A. (2006). 'Making it real': Exploring the potential of augmented reality for teaching primary school science. Virtual Reality, 10(3), 163–174. https://doi.org/10.1007/s10055-006-0036-4
[14] Kesim, M., &Ozarslan, Y. (2012). Augmented reality in education: Current technologies and the potential for education. Procedia - Social and Behavioral Sciences, 47, 297–302. https://doi.org/10.1016/j.sbspro.2012.06.654
[15] Kipper, G., & Rampolla, J. (2013). Augmented Reality: An Emerging Technologies Guide to AR. Syngress
[16] Nemec, J., &Trna, J. (2007). Edutainment or entertainment: Education possibilities of didactic games in science education. In J. Nemec (Ed.), The Evolution of Children Play, 24th ICCP World Play Conference (pp. 55–64). Masaryk University
[17] Oppegaard, B., & Grigar, D. (2014). The interrelationships of mobile storytelling: Merging the physical and the digital at a national historic site. In J. Farman (Ed.), The Mobile Story: Narrative Practices with Locative Technologies (pp. 17–33). Routledge.
[18] Radu, I. (2014). Augmented reality in education: A meta-review and cross-media analysis. Personal and Ubiquitous Computing, 18(6), 1533–1543. https://doi.org/10.1007/s00779-013-0747-y
[19] Rasimah, C., Ahmad, A., & Zaman, H. (2011). Evaluation of user acceptance of mixed reality technology. Australasian Journal of Educational Technology, 27(8), 1369–1387. https://doi.org/10.14742/ajet.899
[20] Smith, D. (2004). Issues and trends in higher education biology fieldwork. Journal of Biological Education, 39(1), 6–10. https://doi.org/10.1080/00219266.2004.9655945
[21] Azuma, R. (1997). A survey of augmented reality. Presence: Teleoperators and Virtual Environments, 6(4), 355–385. https://doi.org/10.1162/pres.1997.6.4.355
[22] Bitter, G., & Corral, A. (2014). The pedagogical potential of augmented reality apps. International Journal of Engineering Science Invention, 3(10), 13–17.
[23] Bower, M., Howe, C., McCredie, N., Robinson, A., & Grover, D. (2014). Augmented Reality in education – Cases, places and potentials. Educational Media International, 51(1), 1–15. https://doi.org/10.1080/09523987.2014.889400
[24] Chang, G., Morreale, P., &Medicherla, P. (2010). Applications of augmented reality systems in education. In D. Gibson & B. Dodge (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference 2010 (pp. 1380–1385). Association for the Advancement of Computing in Education (AACE).
[25] Chou, R. (2017). Going out into the field: An experience of the landscape architecture studio incorporating service-learning and participatory design in Taiwan. Landscape Research, 43(6), 784–797. https://doi.org/10.1080/01426397.2017.1290226
[26] Dunleavy, M., Dede, C., & Mitchell, R. (2009). Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. Journal of Science Education and Technology, 18(1), 7–22. https://doi.org/10.1007/s10956-008-9119-1
[27] Ertmer, P., Ottenbreit-Leftwich, A., Sadik, O., Sendurur, E., &Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. Computers & Education, 59(2), 423–435. https://doi.org/10.1016/j.compedu.2012.02.001
[28] Jarvin, L. (2015). Edutainment, games, and the future of education in a digital world. New Directions for Child and Adolescent Development, 2015(147), 33–40. https://doi.org/10.1002/cad.20082
[29] Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2014). NMC Horizon Report: 2014 Higher Education Edition. The New Media Consortium.
[30] Kerawalla, L., Luckin, R., Seljeflot, S., & Woolard, A. (2006). 'Making it real': Exploring the potential of augmented reality for teaching primary school science. Virtual Reality, 10(3), 163–174. https://doi.org/10.1007/s10055-006-0036-4
[31] Kesim, M., &Ozarslan, Y. (2012). Augmented reality in education: Current technologies and the potential for education. Procedia - Social and Behavioral Sciences, 47, 297–302. https://doi.org/10.1016/j.sbspro.2012.06.654
[32] Kipper, G., & Rampolla, J. (2013). Augmented Reality: An Emerging Technologies Guide to AR. Syngress.
[33] Nemec, J., &Trna, J. (2007). Edutainment or entertainment: Education possibilities of didactic games in science education. In J. Nemec (Ed.), The Evolution of Children Play, 24th ICCP World Play Conference (pp. 55–64). Masaryk University.
[34] Oppegaard, B., & Grigar, D. (2014). The interrelationships of mobile storytelling: Merging the physical and the digital at a national historic site. In J. Farman (Ed.), The Mobile Story: Narrative Practices with Locative Technologies (pp. 17–33). Routledge.
[35] Radu, I. (2014). Augmented reality in education: A meta-review and cross-media analysis. Personal and Ubiquitous Computing, 18(6), 1533–1543. https://doi.org/10.1007/s00779-013-0747-y

[36] Rasimah, C., Ahmad, A., & Zaman, H. (2011). Evaluation of user acceptance of mixed reality technology. Australasian Journal of Educational Technology, 27(8), 1369–1387. https://doi.org/10.14742/ajet.899
[37] Smith, D. (2004). Issues and trends in higher education biology fieldwork. Journal of Biological Education, 39(1), 6–10. https://doi.org/10.1080/00219266.2004.9655945



10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY