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Garden beyond reality: How the metaverse is transforming landscape gardening

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ABSTRACT

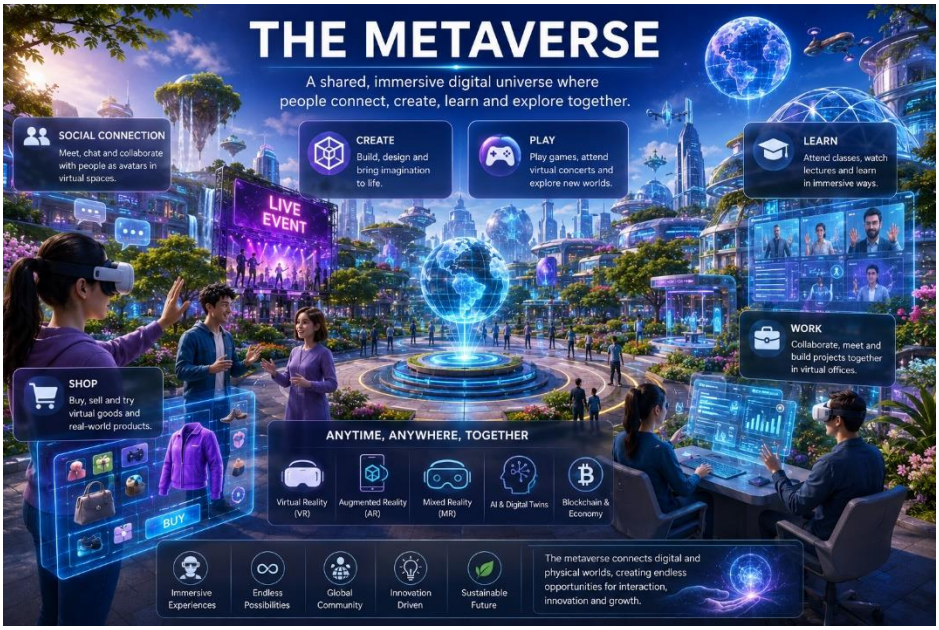
The metaverse is emerging as a transformative technology in landscape gardening by integrating Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), artificial intelligence, and digital twin technologies into landscape planning and management. Unlike traditional design methods that rely on two-dimensional drawings and static models, metaverse-based platforms provide immersive and interactive environments where designers, students, and clients can visualize, evaluate, and modify landscapes before physical implementation. These technologies facilitate realistic simulations of plant growth, seasonal variations, spatial relationships, and user experiences, leading to improved design accuracy, enhanced client participation, reduced project costs, and sustainable resource utilization. Applications in education, plant selection, project presentation, and environmental visualization demonstrate the growing potential of immersive technologies in horticulture and landscape architecture. Despite challenges related to cost, technical limitations, and standardization, the metaverse offers promising opportunities for developing smarter, more efficient, and future-ready landscape gardening practices.

***Key Words*:** Metaverse, Landscape Gardening, Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), Digital Twins, Immersive Technologies, Landscape Architecture, Plant Visualization, Smart Landscaping, Sustainable Design and Horticultural Innovation.

INTRODUCTION

Landscape gardening has always been a blend of science, art, and imagination. Designers must visualize how plants, pathways, water features, and structures will appear for years into the future, considering plant growth, seasonal changes, and user experiences. Traditionally, landscape plans

were communicated through sketches, drawings, photographs, and physical models. While these methods helped in conceptualization, they often failed to convey the true scale, depth, and experience of a landscape.



Today, rapid advances in digital technologies are changing the way landscapes are designed, taught, and managed. Among these innovations, Metaverse has emerged as a revolutionary platform that combines Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), artificial intelligence, and digital twins to create immersive digital environments. Through these technologies, designers and clients can walk through virtual gardens, test design alternatives, and experience landscapes long before construction begins (Mystakidis, 2022; Ritterbusch and Teichmann, 2023).

The metaverse is not intended to replace real gardens; rather, it serves as a powerful tool that bridges imagination and reality, helping create more efficient, sustainable, and visually appealing landscapes.

Understanding the Metaverse

The term "Metaverse" was first introduced by Neal Stephenson in his 1992 science-fiction novel *Snow Crash*. It refers to a shared digital universe where users interact with virtual environments through digital avatars. Today, advances in computing power, internet connectivity, VR, AR, and AI have transformed this once-fictional concept into a practical technology platform.

In landscape gardening, the metaverse provides a virtual space where designers, students, researchers, and clients can collaboratively create, evaluate, and modify landscapes in real time. Unlike conventional computer-aided designs viewed on flat screens, metaverse environments offer immersive experiences that closely resemble real-world interactions.

Technologies Powering the Metaverse

Virtual Reality (VR)

Virtual Reality creates a fully immersive digital environment using head-mounted displays and motion-tracking systems. Users can move through virtual gardens, observe planting layouts, and experience spaces at human scale.

VR offers several advantages in landscape gardening:

- Accurate visualization of spatial relationships.

- Simulation of plant growth and seasonal changes.
- Virtual garden walkthroughs for clients.
- Enhanced learning experiences for students.
- Reduction in design errors and construction modifications.

Research has shown that VR significantly improves students' understanding of scale, realism, and spatial relationships in landscape architecture education (Ha *et al*., 2024).

Augmented Reality (AR)

Unlike VR, which replaces reality, Augmented Reality overlays digital information onto the real world. Using smartphones, tablets, or smart glasses, users can view virtual plants, pathways, and structures directly within an existing site.

Applications of AR in landscape gardening include:

- On-site visualization of landscape proposals.
- Plant identification through QR codes.
- Nursery management and plant information systems.
- Visualization of floral arrangements and color schemes.
- Location-specific plant selection and placement.

Shinde *et al*. (2024) demonstrated that AR-based plant selection systems significantly improve planting decisions and reduce trial-and-error planting practices.

Mixed Reality (MR)

Mixed Reality blends the real and digital worlds, allowing virtual objects to interact with physical environments. Through devices such as Microsoft HoloLens or Meta Quest headsets, users can place holographic trees, shrubs, and structures into real landscapes and evaluate their appearance and functionality.

MR supports:

- Real-time design evaluation.
- Interactive plant studies.
- Collaborative design sessions.
- Client participation in decision-making.
- Visualization of plant growth stages and landscape evolution.

Recent developments have even enabled the creation of digital twins of living plants, allowing users to visualize plant responses to environmental conditions such as sunlight, rain, and wind (Hu *et al*., 2024).

Why the Metaverse Matters in Landscape Gardening

Enhanced Visualization

Traditional landscape drawings often fail to communicate the actual experience of a space. The metaverse enables users to walk through landscapes virtually, providing a realistic understanding of scale, depth, and design intent.

Simulation of Plant Growth

Landscapes are dynamic systems. Trees mature, flowers bloom, and seasonal changes alter the appearance of outdoor spaces. Metaverse technologies can simulate these changes over months and years, helping designers make informed decisions regarding species selection and planting arrangements.

Better Client Communication

Clients frequently struggle to interpret technical drawings. Through immersive virtual environments, clients can explore proposed landscapes, suggest modifications, and gain confidence in design decisions before implementation.

Reduced Costs and Errors

Virtual testing helps identify design flaws before construction begins. Problems related to plant spacing, circulation patterns, visibility, and functionality can be corrected early, saving time and reducing project costs.

Sustainable Landscape Planning

The metaverse promotes sustainability by minimizing material wastage, reducing the need for physical prototypes, and allowing designers to test climate-resilient planting schemes and water-efficient landscapes before execution.

Educational Benefits

Students can access virtual gardens, nurseries, and landscape projects regardless of geographical constraints. Immersive learning environments improve engagement, understanding, and retention of complex landscape concepts (Radianti *et al*., 2020).

Real-World Applications and Case Studies

VR Garden: A Virtual Classroom for Landscape Education

Researchers developed the VR Garden platform to improve landscape architecture education by combining plant identification, virtual garden exploration, and immersive planting design.

The platform allows students to:

- Learn plant identification using 3D models.
- Explore famous Chinese classical gardens virtually.
- Practice planting design using natural hand gestures.

Studies involving 25 students revealed improved learning outcomes, better spatial understanding, and higher satisfaction compared with conventional teaching methods (Zhang *et al*., 2025).

Virtual and Augmented Reality for Landscape Presentation

A study conducted in Turkey compared hand drawings, CAD, VR, and AR as landscape presentation techniques. Expert landscape architects consistently rated VR and AR higher than traditional methods in realism, effectiveness, and spatial understanding (Soydan and Benliay, 2020).

AR-Based Plant Selection

Researchers developed a location-based AR system that allows users to place virtual plants within actual sites before planting. The technology improved plant selection accuracy, reduced planting errors, and enhanced decision-making (Shinde *et al*., 2024).

Eye of Flora: Communicating with Plants through Mixed Reality

One of the most fascinating developments is the "Eye of Flora" project in Taiwan and Japan. Researchers combined plant bioelectrical signals with mixed reality systems to create digital twins

of living plants. Users could visualize plant responses to sunlight, rain, and wind through dynamic particle effects, creating a deeper emotional connection with nature (Hu *et al*., 2024).

Challenges and Limitations

Despite its promise, metaverse technology faces several challenges:

High Infrastructure Costs

Advanced VR headsets, graphics processors, sensors, and computing systems require substantial investment.

Technical Constraints

Motion sickness, tracking errors, limited field of view, and software limitations can affect user experience.

Data Privacy Concerns

Immersive systems collect large volumes of personal and spatial data, raising concerns regarding privacy and security.

Lack of Standardization

Compatibility issues among different platforms and devices hinder seamless integration.

Development Complexity

Creating realistic virtual landscapes and accurate plant models requires specialized expertise and resources.

Social and Environmental Concerns

Extended use of immersive technologies may affect social interactions, while electronic hardware production contributes to environmental impacts.

Future Prospects

The future of metaverse-based landscape gardening is highly promising. Integration with artificial intelligence, Internet of Things (IoT) sensors, digital twins, and climate modeling systems will enable:

- Real-time monitoring of landscape performance.
- Predictive plant growth simulations.
- Smart irrigation management.
- Climate-resilient landscape planning.
- Global collaborative design environments.

As hardware becomes more affordable and software platforms become more accessible, metaverse technologies are expected to become a standard component of landscape architecture, horticulture education, and professional practice.

CONCLUSION

The metaverse represents a major technological leap in landscape gardening. By integrating Virtual Reality, Augmented Reality, and Mixed Reality, it enables designers, educators, and clients to visualize, evaluate, and refine landscapes with unprecedented realism and precision. From virtual garden walkthroughs and plant growth simulations to digital twins and immersive learning platforms, these technologies are reshaping how landscapes are conceived and experienced.

Although challenges related to cost, technical complexity, and standardization remain, the potential benefits are immense. The metaverse is not replacing nature; instead, it is helping us design greener, smarter, and more sustainable landscapes for the future.

REFERENCES

Ha, J., Alrayyan, K. and Alam, M.L. (2024). Virtual reality technology for learning detailed design in landscape architecture. *Discover Education*, 3(1): 39.

Hu, Y., Fol, C., Chou, C., Griess, V. and Kakehi, Y. (2024). Eye of Flora: Encountering nature through the mixed reality lens of plant-environment interactions.

Milgram, P. and Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE Transactions on Information and Systems*, 77(12):1321–1329.

Mystakidis, S. (2022). Metaverse. *Encyclopedia*, 2(1): 486–497.

Radianti, J., Majchrzak, T.A., Fromm, J. and Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education. *Computers & Education*, 147:103778.

Ritterbusch, G.D. and Teichmann, M.R. (2023). Defining the metaverse: A systematic literature review. *IEEE Access*, 11:12368–12377.

Shinde, R., Raut, A., Arjun, A., Bankar, H. and Dhage, S. (2024). Location based plant selection through augmented reality. *International Research Journal of Engineering and Technology*, 11:2395–0056.

Soydan, O. and Benliay, A. (2020). Virtual and augmented reality applications in landscape design and project presentation techniques. *Turkish Journal of Agriculture-Food Science and Technology*, 8:33–37.

Whyte, J. (2002). *Virtual Reality and the Built Environment*. Oxford: Architectural Press.

Zhang, C., Wang, M., Li, M., Pan, Z. and Mao, R. (2025). VR Garden: An interactive teaching platform for higher education in landscape architecture. *SIGGRAPH Asia Educator's Forum*, 25:1–8.