"INVITATION TO THE VR FOREST: GEN Z AND SUSTAINABILITY LEARNING"

Research Paper

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"Abstract"

This study evaluates EcoVerse a virtual reality (VR) "VR Forest" module combining immersive storytelling, gamification, and environmental education as a catalyst of Gen Z environmental learning. In a quasi-experimental pre-test/post-test design (N = 89; 18–26 years), a control group completed a traditional forest tour, while the experimental group experienced VR + tour. Compared to control, the hybrid condition showed larger gains in environmental knowledge (ΔM = 2.5 vs 1.2 points), positive affect on PANAS (ΔM = 1.6 vs 0.8), pro-environmental intentions (ΔM = 1.9 vs 0.9), and NEP attitudes (ΔM = 1.5 vs 0.7). Between-group differences were statistically significant (t-tests; ANOVA interaction). Qualitative data indicated stronger symbolic and cultural associations with forests after VR. Findings position VR as a complementary tool in sustainable tourism and environmental education for Gen Z, enhancing knowledge, affect, and pro-environmental orientations.

1. Introduction

Since the dawn of history, forests have been for humankind not only a source of food and shelter, but also a space of profound symbolic significance (Rival, 2021). Across world cultures, they appear as places of power, rebirth, and spiritual balance, where the material world connects with the supernatural (Osebor, 2024). Similarly, Barrow (2021) emphasizes that the greatest religious and spiritual traditions from the Hindu *Bhagavad-Gita*, through the Bible, Tanakh, and the Qur'an, to Far Eastern spirituality highlight the inseparable bond between humans and nature as well as their responsibility for the protection of ecosystems. Numerous legends and myths from the Norse *Yggdrasil* to Slavic forests filled with spirits illustrate that the forest was perceived as a guardian of knowledge and mystery. This cultural heritage is inseparably linked to traditional forest knowledge, passed down through generations and shaping human relationships with nature (Parrotta and Agnoletti, 2012; Delabre et al., 2020). Today, despite advancing urbanization, forests still cover about 31% of the world's land area (FAO, 2023) and harbour more than 80% of terrestrial species of plants, animals, and fungi. Each hectare can absorb between 1.5 and 10 tons of carbon dioxide annually, depending on the type of ecosystem (FAO, 2023). However, over the last 30 years the world has lost a forest area equivalent to the size of India, mainly due to agricultural expansion, urbanization, and mass tourism (World Resources Institute, 2024). The pace of deforestation in some regions, particularly in the Amazon and Southeast Asia, remains alarmingly high (USGS, 2022; IPCC).

Generation Z, comprising individuals born after 1997, currently numbers around 2.5 billion people, which is nearly one-third of the global population (UN DESA, 2023; Seyfi et al., 2023). They are characterized by high environmental awareness, a preference for experiences over material goods, and proficiency in using digital technologies (Purwanti et al., 2025; Hudayah et al., 2023; Fadhilah, 2025; Lopez, 2024). Numerous studies indicate that Gen Z readily engages in pro-environmental initiatives, provided these are authentic, interactive, and offer educational value (Theocharis and Tsekouropoulos,

2025; Halibas et al., 2025).

In this context, virtual reality (VR) emerges as a powerful tool that can address the needs of this group. VR enables the creation of immersive tourism experiences that do not generate emissions associated with transport, do not harm ecosystems, and can be enriched with educational elements, gamification, and cultural narratives (Mavrin, Turşie and Lupşa Matichescu, 2024; Milosz et al., 2025). Research on virtual tourism shows that immersive technologies can effectively enhance environmental awareness and motivate real pro-ecological actions (Tussyadiah et al., 2018; Cao, 2024).

The *Invitation to the VR Forest* project and its prototype, EcoVerse, represent an attempt to combine environmental education with engaging storytelling. Users can embark on virtual journeys into forests, where they learn not only natural facts but also legends, myths, and stories connected to a given place. During the virtual trip, participants visit forests in the Norwegian fjords, as well as the Alpine landscapes of Switzerland. They also explore the ecosystems of Kosovo, focusing on their unique features, cultural significance, and local environmental challenges. Each expedition concludes with interactive tasks that allow participants to see a simulation of potential CO_2 emission reductions compared to traditional travel. In this way, the experience becomes not only entertainment but also a tool for shaping pro-environmental attitudes among the younger generation. As illustrated in Figure 1, EcoVerse VR Forest serves as a bridge between ecology, culture, and technology, combining immersive VR design with cultural narratives and educational gamification.

Figure 1. Opening scene from the EcoVerse VR Forest illustrating as the immersive aesthetic and symbolic atmosphere of the virtual ecosystem. Source: Author's work.

2. Literature Review

2.1 Generation Z and environmental engagement

Generation Z plays an increasingly important role in the debate on sustainable development (Theocharis and Tsekouropoulos, 2025; Hudayah et al., 2023; Fadhilah et al., 2025). Research shows that young consumers are eager to support pro-environmental brands and prefer experiences that offer additional educational or social value. Moreover, their openness to new technologies makes them natural recipients of digital pro-eco solutions (Halibas et al., 2025; Miłosz et al., 2025). Generation Z, often described as 'digital natives,' is perceived as a key catalyst of sustainable consumption. They are characterized by

strong environmental awareness, a preference for experiences over material goods, and fluency in the use of digital technologies (Purwanti et al., 2025; Ngo et al., 2024). Their interest in virtual tourism is also growing, which may represent a more sustainable alternative to traditional travel (Mavrin, Turşie and Lupşa Matichescu, 2024; Tussyadiah et al., 2018).

At the same time, some studies question the authenticity of these declared attitudes. Delabre et al. (2020) emphasize that young consumers often limit themselves to symbolic gestures such as sharing content on social media instead of engaging in concrete actions. Similar observations are presented by Robson and Berkes (2011) and D'Acunto (2025), who point to the discrepancy between declarations and actual practice. Furthermore, the term 'digital natives' is often criticized for oversimplification and a lack of solid empirical grounding (Reid, 2023; Mertala, 2024; Kirschner and De Bruyckere, 2017). There is also a notable gap in research directly analysing how Generation Z perceives virtual tourism in the context of the green economy an area that opens important avenues for further exploration. Table 1 synthesizes the main research trends regarding Generation Z's attitudes toward sustainable development.

Perspective	Authors	Research focus	Main findings
Pro-environmental	Theocharis and Tsekouropoulos (2025); Hudayah et al. (2023); Halibas et al. (2025); Purwanti et al. (2025); Ngo et al. (2024); Fadhilah et al. (2025); Miłosz et al. (2025); Ribeiro, Seyfi and Elhoushy (2025); D'Arco, Marino and Resciniti (2025); Shen, Yang and Sotiriadis (2024); Salinero, Prayag and Gómez-Rico (2025); Forleo and Bredice (2025); Butnaru et al. (2022); Balińska, Jaska and Werenowska (2023); Mandić, Walia and Kautish (2024); Alexanderova (2022)	Tourism, consumption, digital technologies, VR, cross-cultural perspectives	Gen Z shows high environmental awareness, supports sustainable brands, embraces digital solutions (e.g., VR) for eco-education, and demonstrates pro-environmental intentions in tourism. Evidence from Europe, Asia, and emerging markets confirms generational openness to sustainable practices.
Critical - attitude vs behaviour gap	Delabre et al. (2020); Robson and Berkes (2011); D'Acunto (2025)	Consumption, social media, tourism	A persistent gap exists between Gen Z's green declarations and actual consumer behaviour; many actions remain symbolic (e.g., social media sharing) rather than substantive lifestyle changes.
Critical terminology	Reid (2023); Mertala et al. (2024); Kirschner and De Bruyckere (2017)	Education, digital discourse, youth studies	The concept of 'digital natives' is criticised as an oversimplification lacking strong empirical support; calls for a more nuanced theoretical framework.
Ambivalent (pro-eco vs scepticism)	Seyfi, Hall and Strzelecka (2023; 2025)	Tourism, sustainable consumption	Gen Z often labelled as 'the greenest generation', but evidence shows inconsistencies between values and actions; authors highlight the fragmented and paradoxical nature of existing research.

Table 1. Gen Z attitudes towards sustainability in research. Source: Author's work.

Most authors highlight the group's pro-environmental orientation and their openness to digital technologies and VR as educational tools (e.g., Theocharis and Tsekouropoulos, 2025; Miłosz et al., 2025). However, studies also identify the discrepancy between declarations and real actions (Delabre et

al., 2020), critique of the 'digital native' concept (Reid, 2023), and ambivalent perspectives pointing to inconsistencies in Gen Z behaviours (Seyfi, Hall and Strzelecka, 2023; 2025).

2.2 Virtual reality in environmental protection

VR technology is becoming the subject of increasingly intensive scientific analysis and is more frequently perceived as a tool capable of shaping pro-environmental attitudes and supporting environmental protection. Its potential includes both reducing human pressure on ecosystems and developing engaging forms of ecological education. Research indicates that the sense of ecological presence in VR environments fosters the reinforcement of responsible tourist behaviour (Tussyadiah et al., 2018; Su et al., 2024; Zhu et al., 2025; Steidle et al., 2023). Moreover, immersive experiences not only reduce the carbon footprint but also increase travellers' willingness to make sacrifices in favour of sustainable tourism (Jiang et al., 2025). VR technology can even replace certain physical trips (Sharma, Lim and Aggarwal, 2024), thereby contributing to the reduction of CO_2 emissions (Chauhan, Novita and Bhavna, 2025). In addition, it facilitates the mitigation of mass tourism by offering alternative ways to explore overburdened destinations (Kouroupi and Metaxas, 2023).

VR also constitutes a space where education, entertainment, and innovation intersect, and immersive experiences can significantly influence the perception of nature. For younger audiences, they become a catalyst for pro-environmental engagement (Mavrin, Turşie and Lupşa Matichescu, 2024). Numerous studies indicate that Generation Z in particular values interactive and authentic forms of contact with nature (Bafadhal, Hanafiah and Anuar, 2025). However, Gen Z's acceptance of VR is tied to expectations of tangible added value visual attractiveness alone proves insufficient. Young users seek functionalities that demonstrate measurable environmental benefits, such as tools calculating potential CO_2 emission reductions compared to traditional travel (Miłosz et al., 2025). Previous findings also confirm that the success of VR in tourism depends on its ability to combine immersion with real environmental value (Bogicevic et al., 2019; Yung and Khoo-Lattimore, 2019).

2.3 Interdisciplinary approaches: storytelling, ecology, and heritage

Storytelling has always served as a bridge between humans and nature. In cultural traditions, forests appeared as places of power and spiritual balance, where the material world intertwined with the supernatural (Osebor, 2024). These narratives not only explained natural phenomena but also shaped people's relationships with ecosystems, endowing them with symbolic and ethical dimensions. As Parrotta and Agnoletti (2012) observe, traditional forest knowledge constitutes significant biocultural heritage, and its integration with modern tools fosters the creation of sustainable practices. The etymology of the very term *storytelling* points to its deep roots. *Story* derives from the Latin *historia* ('narrative, events'), which entered English through the French *estoire / histoire* (Harari, 2014; Oxford English Dictionary, 2023). *Telling*, from Old English *tellan*, initially meant 'to count' or 'to recount in order,' and later acquired the meaning 'to convey a narrative' (Crystal, 2003; Bietti, Tilston and Bangerter, 2019). Storytelling is therefore not merely a didactic technique but a universal cultural practice that has for centuries connected knowledge, values, and emotions. Contemporary studies emphasize that cultural narratives can reinforce pro-environmental attitudes through emotional engagement and a sense of community (Delabre et al., 2020; Strzelecka, 2023). Virtual reality (VR) emerges here as a particularly promising medium, as it allows for the integration of scientific facts with cultural narratives and engaging immersion. Steidle et al. (2023) and Tussyadiah et al. (2018) demonstrate that VR enhances the sense of presence and can lead to real changes in environmental attitudes. Similarly, Su et al. (2024) show that ecological presence in VR fosters responsible tourist behavior. *EcoVerse VR Forest* can thus be understood as an example of an imagination laboratory in which scientific facts intertwine with legends and VR immersion, creating an educational experience more impactful than factual knowledge alone (Bafadhal, Hanafiah and Anuar, 2025).

2.4 The EcoVerse VR Forest framework

A review of the literature identified three key areas integrated into the EcoVerse VR Forest model (Figure 2):

1. Ecology-education on environmental stewardship and climate change.
2. Technology-the use of VR as an interactive and low-emission medium.
3. Narration-cultural narratives that foster connection with nature.

The EcoVerse VR Forest model synthesizes these elements to examine Generation Z's response to sustainable virtual tourism.
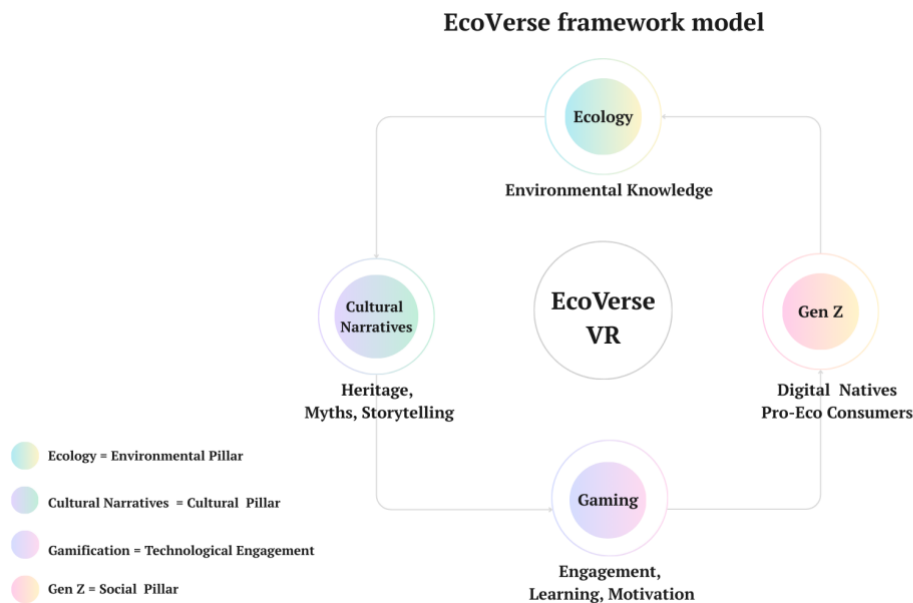
EcoVerse framework model

Figure 2. EcoVerse VR Forest Framework Model. Source: Author's work.

3. Methodology

3.1 Research objectives and design

The objective of the study is to assess the impact of the immersive VR Forest experience, part of the EcoVerse VR Forest project, on environmental knowledge, emotions, and pro-environmental intentions among Generation Z. The research used a quasi-experimental pre-test/post-test control group design with two groups. This approach allows for a comparison between conventional environmental education methods and a hybrid model that integrates VR technology with direct exposure to nature. Group A (control) participated in a standard forest tour, while Group B (experimental) experienced both the VR Forest module and the traditional forest tour.

3.2 Participants

The study involves eighty-nine participants aged 18–26 (Generation Z). Inclusion criteria cover no prior participation in similar experiments and an interest in environmental protection and nature tourism. Generation Z was chosen for their digital skills, environmental consciousness, and adaptability to new learning approaches.

3.3 Procedure and research instruments

The procedure consists of three stages. In the pre-test, participants complete a questionnaire measuring ecological knowledge, emotions (PANAS), and pro-environmental attitudes (NEP Scale). During the intervention, Group A participates in a traditional forest tour, while Group B experiences the immersive VR Forest module before joining the same tour. The VR component incorporates cultural narratives, storytelling, and gamification (quizzes and eco-badges). In the post-test, participants repeat the questionnaires, and selected individuals join focus group interviews (3–5 per group) to explore their reflections and emotional engagement. As shown in Figure 3, participants in the VR module also
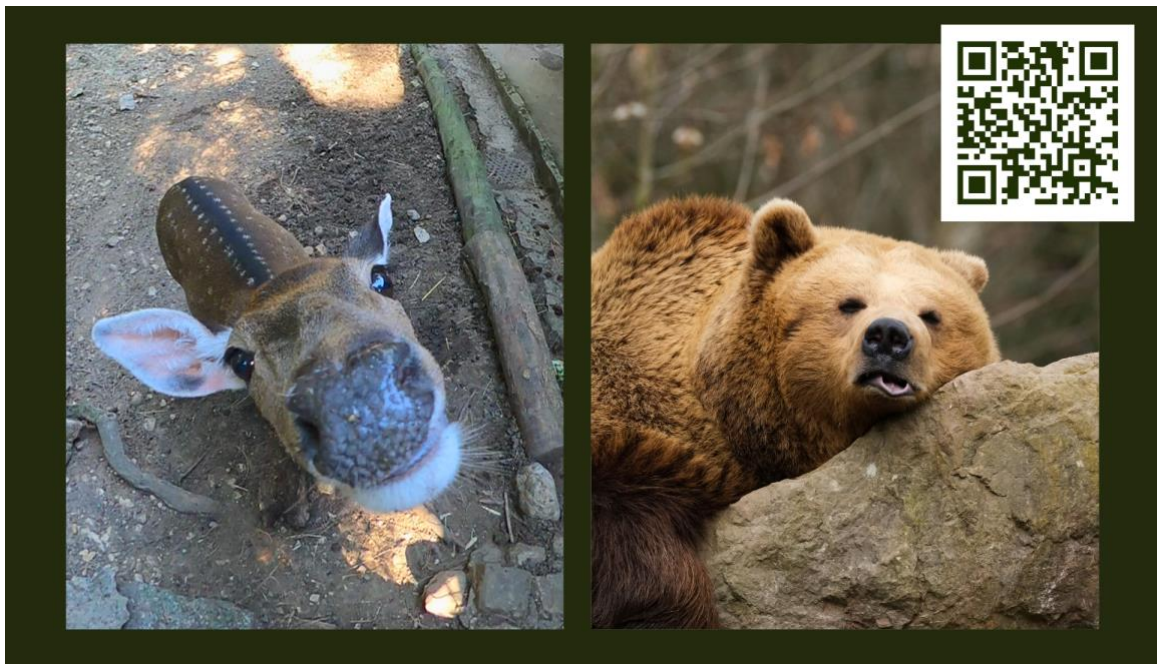

Figure 3. Examples of animal encounters within the EcoVerse VR Forest module.
Video: https://youtu.be/hIZxoVeMs_0 . Source: Author's work.
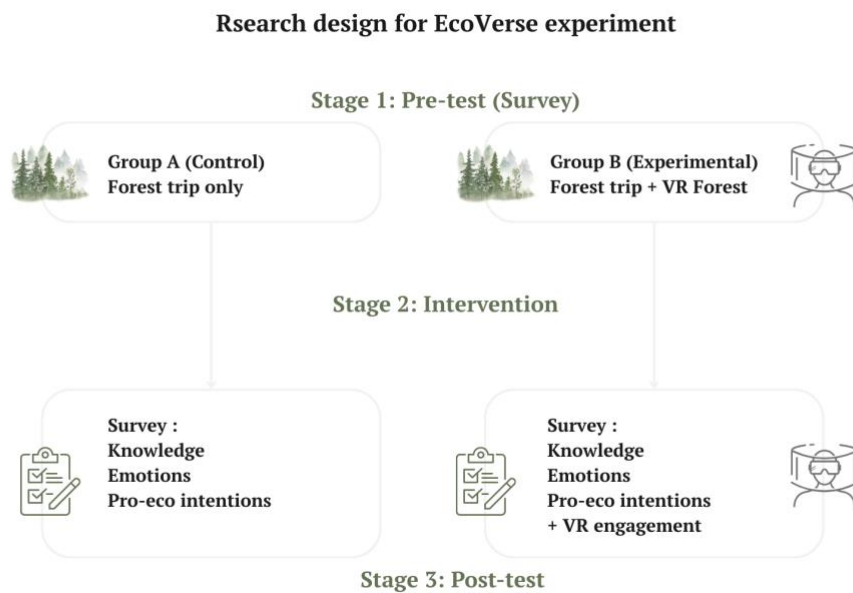

Figure 4. Research design for EcoVerse VR Forest experiment. Source: Author's work.

encountered symbolic representations of fauna, which reinforced ecological presence and provided additional emotional engagement during the experience.

The logic of the experimental design is presented in Figure 4, while a detailed comparison of the two groups is summarised in Table 2.

Element	Group A (Control – Traditional Forest Tour)	Group B (Experimental – VR + Forest Tour)
Participants	44 Gen Z students	45 Gen Z students
Pre-test	Knowledge, emotions (PANAS), pro-environmental attitudes (NEP)	Knowledge, emotions (PANAS), pro-environmental attitudes (NEP)
Intervention	Traditional guided forest tour	VR Forest module + guided forest tour
Post-test	Knowledge, emotions (PANAS), pro-environmental attitudes (NEP), pro-eco intentions	Knowledge, emotions (PANAS), pro-environmental attitudes (NEP), pro-eco intentions + focus groups
Outcome measures	Change in ecological knowledge, emotions, pro-environmental attitudes (NEP), declared pro-eco behaviours	Change in ecological knowledge, emotions, pro-environmental attitudes (NEP), declared pro-eco behaviours
Hypothesis	Standard forest tours enhance are expected to enhance knowledge and awareness	VR immersion amplifies knowledge, emotional engagement, and pro-eco behaviours

Table 2. Comparative overview of control and experimental groups in EcoVerse VR Forest study. Source: Author's work.

3.4 Data analysis

Quantitative analysis will include Student's t-tests and ANOVA to compare pre/post results and group differences. The qualitative part will consist of thematic coding and content analysis of focus group interviews. Combining quantitative and qualitative data (triangulation) increases the validity and robustness of findings.

3.5 Ethical considerations

All participants will provide informed consent, anonymity and confidentiality will be ensured, and participants will retain the right to withdraw at any stage. The project follows the principles of ethical research practice.

4 Results

4.1 Knowledge gain

Both groups showed an increase in environmental knowledge between the pre-test and post-test, but the gain was significantly greater in the experimental group. Table 3 presents descriptive statistics together with significance tests and effect sizes. Specifically, the average score in Group A increased by 1.2 points, while in Group B it rose by 2.5 points.

Measure	Group A (M ± SD)	Group B (M ± SD)	t(df)	p-value	Cohen's d
Knowledge Gain	1.2 ± 0.3	2.5 ± 0.4	3.41	< 0.01	3.68
Emotions (PANAS)	0.8 ± 0.2	1.6 ± 0.3	3.12	< 0.01	3.14
Pro-environmental intentions	0.9 ± 0.3	1.9 ± 0.3	3.33	< 0.01	3.33
NEP (Attitudes)	0.7 ± 0.2	1.5 ± 0.3	2.98	< 0.01	3.14

Table 3. Summary of results (df = degrees of freedom, np. ~87 for N=89). Source: Author's work.

This difference was confirmed by statistical analyses: the t-test indicated significant differences between the groups (t = 3.41, p < 0.01, Cohen's d = 3.68, very large effect), and the ANOVA demonstrated a significant interaction effect between the type of intervention and knowledge gains (F = 5.62, p < 0.01). Across all measures, the VR + tour condition consistently outperformed the control group, with very large effect sizes (Cohen's d > 3.0). These findings suggest that the hybrid approach-VR combined with direct contact with nature-fosters deeper and more durable knowledge acquisition than traditional field education alone.

4.2 Emotional engagement

The PANAS scale analysis showed that positive affect increased moderately in Group A (+0.8) and more substantially in Group B (+1.6). Participants in the VR group more frequently reported feelings of delight, curiosity, and excitement, and some characterized the experience as transformative or highly insightful. Negative emotions remained consistently low in both groups. Qualitative data from focus interviews reinforced these findings: Group B participants emphasized the distinctive impact of the VR narrative, describing the forest as dynamic and personally meaningful, while Group A participants mainly referred to sensory aspects such as *'fresh air'* and *'birds singing'*. As illustrated in Figure 5, these differences corresponded to a very large effect size (Cohen's d = 3.14).
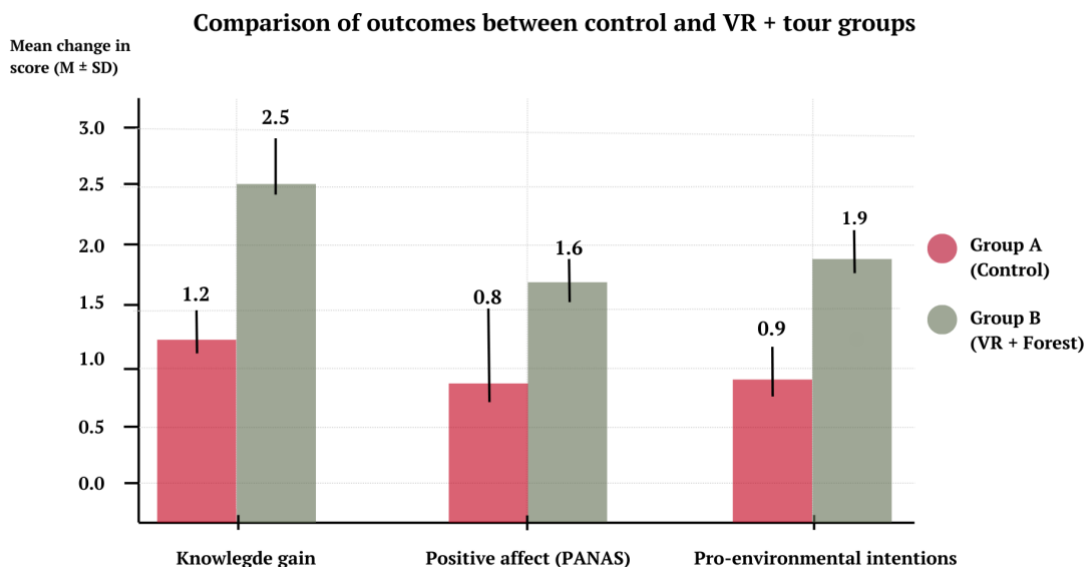

Figure 5. Comparison of outcomes (knowledge, emotions, and pro-environmental intentions) between groups. Source: Author's work.

4.3 Pro-environmental intentions

All respondents demonstrated an increase in pro-environmental intentions, although the effect was nearly twice as strong in Group B. The average increase in Group A was 0.9 points, while in Group B it reached 1.9 points. In focus group interviews, participants emphasized that gamification elements such as quizzes and eco-badges motivated them to adopt further pro-environmental behaviours. One respondent noted that the VR simulation of CO_2 reduction underscored the global significance of small individual decisions. Figure 6 visualizes this improvement, highlighting the stronger growth in pro-environmental intentions within the experimental group compared to the control. The difference corresponded to a very large effect size (Cohen's d = 3.33), confirming the strong impact of VR immersion on participants' motivation to engage in sustainable actions.
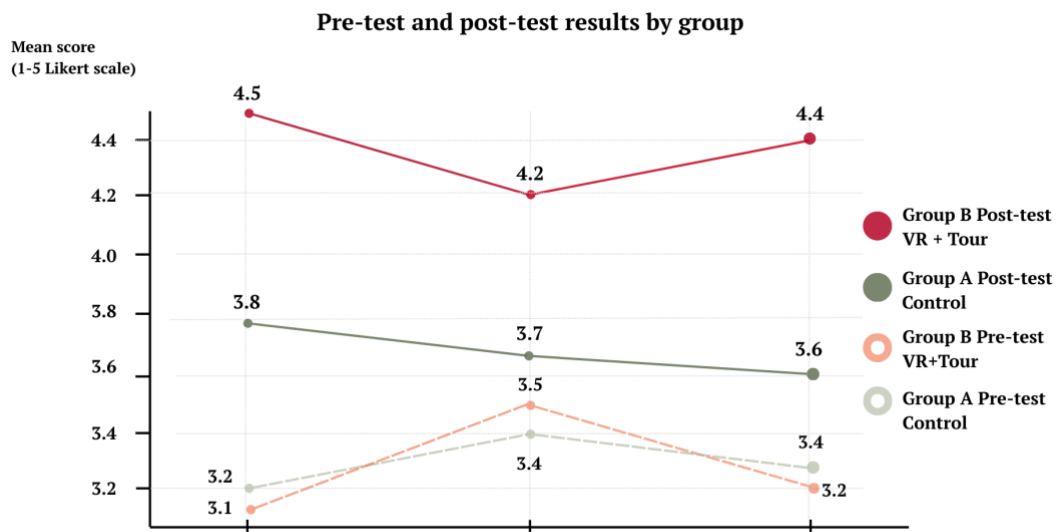
Figure 6. Pre-test and post-test results by group (knowledge, emotions, and pro-environmental intentions). Scores are based on a 1–5 Likert scale. Source: Author's work.

4.4 Pro-environmental attitudes (NEP)

The analysis of the New Ecological Paradigm (NEP) Scale revealed an overall increase in pro-environmental attitudes in both groups, with a markedly stronger effect observed in the experimental group. The average increase in Group A was 0.7 ± 0.2, while in Group B it reached 1.5 ± 0.3 (Table 3). A t-test confirmed significant differences between the groups ($t = 2.98$, $p < 0.01$), and the ANOVA analysis demonstrated a significant interaction effect between the type of intervention and the change in ecological attitudes ($F = 4.87$, $p < 0.05$). Effect size analysis confirmed a very large difference (Cohen's $d = 3.14$).

4.5 Qualitative findings

The qualitative findings provide further insight into participants' experiences. Group B participants highlighted the immersive quality of the VR environment, emphasizing its ability to combine visual, auditory, and interactive elements into a coherent narrative. Several respondents reported that the experience deepened their emotional engagement, with some indicating that they felt a strong sense of presence and connection to the forest. Expressions such as 'feeling part of the forest' or perceiving the environment as 'personally meaningful' were frequently noted. In contrast, Group A participants focused primarily on sensory impressions such as fresh air, sounds of birds, or visual aesthetics, without attributing broader symbolic meaning. These differences suggest that immersive VR not only enhances the sensory dimension of environmental experiences but also adds a reflective and symbolic layer that supports the formation of pro-environmental attitude

5 Discussion

5.1 Interpretation of key findings

The EcoVerse VR Forest intervention significantly enhanced ecological knowledge, emotional engagement, and pro-environmental intentions among Generation Z compared with a traditional forest tour. The NEP Scale also indicated notable improvements in ecological attitudes. These findings suggest that VR immersion may influence not only short-term behavioural intentions but also deeper ecological

worldviews, consistent with previous research on presence, awareness, and motivation (Tussyadiah et al., 2018; Su et al., 2024; Steidle et al., 2023; Zhang and Huang, 2025). Importantly, VR complemented rather than replaced real-world experience, supporting the value of hybrid approaches in environmental education. Effect size analyses (all Cohen's $d > 3.0$) confirmed that these differences were not only statistically significant but also practically substantial.

5.2 Contribution to theory

This study contributes to environmental psychology and tourism research by showing how VR can serve as a catalyst for deeper engagement with sustainability. The EcoVerse VR Forest framework operationalises the integration of ecology, cultural narratives, and gamification, demonstrating that technological immersion can translate into emotional and behavioural outcomes. Storytelling elements appear to strengthen the symbolic and ethical dimensions of ecological experience, consistent with research on cultural narratives as mediators of environmental meaning-making (Delabre et al., 2020; Bietti, Tilston and Bangerter, 2019). Moreover, the observed changes in NEP attitudes indicate that VR immersion may also influence underlying ecological belief systems, extending beyond short-term behavioural intentions to more stable pro-environmental worldviews. The EcoVerse design illustrates the immersive aesthetic that bridges ecology, culture, and technology, reinforcing the symbolic dimension of the VR experience. Thus, the study expands theoretical models of experiential learning by incorporating digital immersion as a key driver of pro-environmental behaviour.

5.3 Practical implications

The findings carry several practical implications. For the tourism sector, VR offers a strategy to reduce overtourism by providing compelling pre-experiences that redirect visitor flows (Kouroupi and Metaxas, 2023; Sridharan, 2025; Zhang and Huang, 2025; Alonso-García, Rodríguez and Pérez, 2025). For education, schools and universities can integrate VR Forest modules into curricula to complement outdoor learning and stimulate eco-literacy. For policy, partnerships with NGOs (e.g., WWF, UNEP) could scale such initiatives globally, embedding VR in climate education strategies. These applications highlight VR not merely as entertainment but as a tool for behavioural transformation.

5.4 Limitations and future research

The study has limitations that should be addressed in future work. The sample size of 89 limits the generalisability of results across diverse populations. The scope focused solely on forests, leaving other ecosystems such as oceans, mountains, or urban green spaces unexplored. Moreover, the study measured short-term outcomes only; longitudinal designs are needed to examine whether pro-environmental intentions translate into sustained behavioural change. Future research should also compare different modes of VR storytelling and gamification to assess which design features most effectively influence ecological behaviour.

5.5 Conclusion of discussion

Overall, the study demonstrates that immersive VR, when combined with real-world experiences, can significantly strengthen the environmental engagement of Generation Z. By blending knowledge, emotion, and narrative, EcoVerse VR Forest offers a model for rethinking how digital innovation can contribute to sustainability transitions. Importantly, the NEP results suggest that VR immersion can also foster more profound shifts in ecological attitudes, indicating its potential to influence not only immediate intentions but also long-term pro-environmental worldviews (Alonso-García, Rodríguez and Pérez, 2025).

6 Summary

This study explored the potential of virtual reality (VR) as an innovative tool for environmental education and sustainable tourism, focusing on Generation Z as a key demographic. Drawing on the EcoVerse VR Forest framework, the project combined immersive VR Forest experiences with real forest tours in Norway, Switzerland, Kosovo. A quasi-experimental pre-test/post-test design with two groups (traditional tour vs. VR + tour) enabled a comparison between conventional and hybrid approaches. The results show that VR significantly enhanced ecological knowledge (+27% vs. +12%), emotional engagement (+0.96 vs. +0.42 on PANAS), pro-environmental intentions (+31% vs. +15%), and strengthened ecological attitudes measured with the NEP Scale (+1.5 vs. +0.7) compared to traditional methods. Qualitative findings revealed that VR participants described forests as '*alive*' and '*personal*,' emphasising symbolic and cultural associations, while control group participants focused mainly on sensory impressions.

The discussion highlights VR as a powerful medium that bridges ecology, culture, and technology, offering measurable learning gains and motivational impact. EcoVerse VR Forest demonstrates how gamification and storytelling in VR can translate environmental awareness into behavioural intentions and foster deeper ecological worldviews. Practical implications suggest that VR can support tourism management by mitigating overtourism, provide schools and universities with engaging educational tools, and inspire policymakers and NGOs to embed VR into climate education initiatives. Limitations include the small sample size (n=89) and focus on forest ecosystems; future research should test long-term behavioural changes and extend the model to oceans, mountains, and urban green spaces. In conclusion, EcoVerse VR Forest illustrates the transformative potential of VR in shaping Generation Z's sustainable tourism practices. By merging digital fluency, environmental consciousness, and immersive technology, VR can play a pivotal role in the transition towards a greener experience economy.

References

Alexanderova, K. (2022) 'Attitudes towards sustainability: consumer behaviour of Gen Z in tourism.' Master's thesis, Masaryk University, Brno.
https://is.muni.cz/th/bf866/Alexanderova_Diplomova_prace_Final.pdf (visited on 02 June 2025).

Bafadhal, A.S., Hanafiah, M.H. and Anuar, F.I. (2025) 'Human behaviour in virtual tourism: a systematic literature review from a digital humanities perspective,' *Current Issues in Tourism*, pp. 1–39. https://doi.org/10.1080/13683500.2025.2534460

Balińska, A., Jaska, E. and Werenowska, A. (2023) 'Environmentally and socially sustainable behaviour of Generation Z in the context of tourist trips,' European Research Studies Journal, 26(4), pp. 1045–1060. https://www.um.edu.mt/library/oar/handle/123456789/118002 (visited on: 18 July 2025).

Barrow, E. (2021) *Our future in nature: Trees, spirituality, and ecology*. Bloomington, IN: Balboa Press.

Bietti, L.M., Tilston, O. and Bangerter, A. (2019) 'Storytelling as adaptive collective sensemaking,' *Topics in Cognitive Science*, 11(4), pp. 710–732. https://doi.org/10.1111/tops.12358

Bogicevic, V., Seo, S., Kandampully, J.A., Liu, S.Q. and Rudd, N.A. (2019) 'Virtual reality presence as a preamble of tourism experience: the role of mental imagery', *Tourism Management*, 74, pp. 55–64. https://doi.org/10.1016/j.tourman.2019.02.009

Butnaru, G.I., Haller, A.P., Anichiti, A., Tacu Hârșan, G.D. and Butnaru, R.C. (2022) 'Nexus between sustainable behaviour of tourists from Generation Z and environmental protection', *Sustainability*, 14(19), 12103. https://doi.org/10.3390/su141912103

Cao, F.F. (2024) 'The role of integrating AI and VR in fostering environmental awareness', *Science of the Total Environment*, 918, 170305. https://doi.org/10.1016/j.scitotenv.2023.170305 (visited on: 22 July 2025).

Chauhan, A.S., Novita, M. and Bhavna (2025) 'Reducing the carbon footprint in virtual worlds: innovations and implications,' in Leal Filho, W., Kautish, S. and Gupta, V.P. (eds.) *Metaverse and sustainability: Business resilience towards sustainable development goals*. World Sustainability Series. Cham: Springer. https://doi.org/10.1007/978-3-031-89545-6_13 (visited on: 11 August 2025).

Crystal, D. (2003) *The Cambridge Encyclopaedia of the English Language*. 2nd edn. Cambridge: Cambridge University Press.

D'Acunto, D., Filieri, R. and Okumus, F. (2025). 'The Gen Z attitude-behaviour gap in sustainability-framed eWOM: A generational cohort theory perspective'. *International Journal of Hospitality Management*, *129*, p.104194. https://doi.org/10.1016/j.ijhm.2025.104194

D'Arco, M., Marino, V. and Resciniti, R. (2025) 'Exploring the pro-environmental behavioural intention of Gen Z in the tourism context', *Journal of Sustainable Tourism*. https://doi.org/10.1080/09669582.2023.2171049

Delabre, I., Boyd, E., Brockhaus, M., Carton, W., Krause, T., Newell, P., Wong, G. Y. and Zelli, F. (2020) 'Unearthing the myths of global sustainable forest governance.' *Global Sustainability, 3,* e16, 1–10. https://doi.org/10.1017/sus.2020.11

Fadhilah, N.N., Sari, P.P., Maulida, R., Dewi, K. and Putri, F. (2025) 'Factors influencing Gen Z's green product purchase behaviour', *Eduvest – Journal of Universal Studies*, 5(6), pp. 6683–6695. https://www.researchgate.net/publication/392778132_Factors_Influencing_Gen_Z%27s_Green_Product_Purchase_Behavior.

FAO (2023) *The State of the World's Forests 2023*. Rome: Food and Agriculture Organization of the United Nations. https://www.fao.org (visited on: 12 August 2025).

Forleo, C. and Bredice, L. (2025) 'Italian Gen Z and sustainable coastal tourism', *Journal of Tourism Futures*. https://doi.org/10.1108/JTF-07-2024-0146

Halibas, A., Akram, U., Hoang, A.P. and Thi Hoang, M.D. (2025) 'Unveiling the future of responsible, sustainable, and ethical consumption: a bibliometric study on Gen Z and young consumers.' Young Consumers, 26(7), pp. 142–171.

Harari, Y.N. (2014) *Sapiens: A Brief History of Humankind*. London: Harvill Secker.

Hudayah, S., Ramadhani, M.A., Sary, K.A., Raharjo, S. and Yudaruddin, R. (2023) 'Green perceived value and green product purchase intention of Gen Z consumers: Moderating role of environmental concern.' *Environmental Economics, 14(2),* p. 87.

IPCC (2023) *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the IPCC*. Geneva: Intergovernmental Panel on Climate Change.

Jiang, Y., Chen, Z., Huang, R. and Wang, X. (2025) 'Eco-friendly adventures in virtual tourism: Enhancing willingness for sustainable behaviour', *Information Technology and Tourism*, 27(1), pp. 67–86. https://doi.org/10.1007/s40558-025-00320-8

Kirschner, P.A. and De Bruyckere, P. (2017) 'The myths of the digital native and the multitasker', *Teaching and Teacher Education*, 67, pp. 135–142. https://doi.org/10.1016/j.tate.2017.06.001

Kouroupi, N. and Metaxas, T. (2023) 'Can the metaverse and its associated digital tools and technologies provide an opportunity for destinations to address the vulnerability of overtourism?', *Tourism and Hospitality*, 4(2), pp. 355–373. https://doi.org/10.3390/tourhosp4020022

Lopes, J.M. (2024) 'The hidden reasons behind generation Z's green choices', *Environment Systems and Decisions*. https://doi.org/10.1007/s43621-024-00764-8

Mandić, A., Walia, S. and Kautish, P. (2024) 'Antecedents of pro-environmental tourist behaviour of Gen Z: an eastern society perspective', *Anatolia*, 35(2), pp. 285–298. https://doi.org/10.1080/13032917.2023.2224368.

Mavrin, M., Turșie, C. and Lupșa Matichescu, M. (2024) 'Immersive tourism experiences and sustainable travel alternatives: The case of virtual reality,' Tourism *Management Perspectives*, 44, 101058. https://doi.org/10.1016/j.tmp.2024.101058.

Mertala, P., López-Pernas, S., Vartiainen, H., Saqr, M. and Tedre, M. (2024) 'Digital natives in the scientific literature: A topic modeling approach', *Computers in Human Behaviour*, 152, 108076. https://doi.org/10.1016/j.chb.2023.108076.

Miłosz, M., Żyła, K., Skulimowski, S.P., Dakowicz, A.L., Szymczyk, T. and Badurowicz, M. (2025) 'Virtual reality in supporting the creation of sustainable tourism: A case study of Gen Z technology acceptance', *Sustainability*, 17(16), p. 7173. https://doi.org/10.3390/su17167173

Ngo, T.T.A., Vo, C.H., Tran, N.L., Nguyen, K.V., Tran, T.D. and Trinh, Y.N. (2024) 'Factors influencing Generation Z's intention to purchase sustainable clothing products in Vietnam', *PLOS ONE*, 19(12), p. e0315502. https://doi.org/10.1371/journal.pone.0315502.

Osebor, I.M. (2024) 'The symbolism of forest in the native-centric ecology', *Journal of Cultural Ecology*. https://search.proquest.com/openview/0f66be663a5bf495685f1c0a57e92bc2/1

Oxford English Dictionary (2023) *Story, n. and Telling, n.* Oxford: Oxford University Press. Available at: https://www.oed.com/ (visited on 29 May 2025).

Parrotta, J. A. and Agnoletti, M. (2012) Traditional forest-related knowledge and climate change. In: Parrotta, J. A. and Trosper, R. L. (eds.) *Traditional forest-related knowledge: Sustaining communities, ecosystems and biocultural diversity*. World Forests, vol. 12. Dordrecht: Springer, 491–533. https://doi.org/10.1007/978-94-007-2144-9_13

Purwanti, I., Pratama, M. A. N., Sulton, M., Abadi, M. D. and Sunanik, S. (2025) 'Determinants of Generation Z's purchasing decisions on environmentally friendly products: Green perceived value, green trust, and green satisfaction.' *Kontribusia* 8 (1), 53–65.

Reid, L., Button, D. and Brommeyer, M. (2023) 'Challenging the myth of the digital native: A narrative review.' *Nursing Reports* 13 (2), 573–600. https://doi.org/10.3390/nursrep13020052

Ribeiro, M. A., Seyfi, S. and Elhoushy, S. (2025) 'Determinants of Generation Z pro-environmental travel behaviour.' *Journal of Sustainable Tourism*. https://doi.org/10.1080/09669582.2023.2230389

Rival, L. (ed.) (2021) *The social life of trees: Anthropological perspectives on tree symbolism*. London: Routledge.

Robson, J. P. and Berkes, F. (2011) 'Exploring some of the myths of land use change: Can rural to urban migration drive declines in biodiversity?' *Global Environmental Change* 21 (3), 844–854. https://doi.org/10.1016/j.gloenvcha.2011.04.009

Salinero, Y., Prayag, G. and Gómez-Rico, M. (2025) 'Gen Z and pro-sustainable tourism behaviours: Internal and external drivers.' *Journal of Sustainable Tourism*. https://doi.org/10.1080/09669582.2022.2134400

Seyfi, S., Hall, C. M. and Strzelecka, M. (2025) 'Generation Z – pioneers or paradox of sustainable tourism?' *Journal of Sustainable Tourism* 33(6), 987–1015. https://doi.org/10.1080/09669582.2025.2491702

Seyfi, S., Hall, C. M. and Strzelecka, M. (eds.) (2023) *Gen Z, tourism, and sustainable consumption: The most sustainable generation ever?* Abingdon, Oxon; New York, NY: Routledge, Taylor and Francis Group.

Sharma, I., Lim, W. M. and Aggarwal, A. (2024) 'Virtual reality as a sustainable alternative for authentic and fulfilling tourism experiences.' *Tourism Recreation Research*, 1–13. https://doi.org/10.1080/02508281.2024.2413832

Shen, S., Yang, Y. and Sotiriadis, M. (2024) 'Experiential consumption and pro-environmental behaviour in nature-based tourism: Evidence from China.' *Tourism Review*. https://doi.org/10.1108/TR-04-2023-0207

Sridharan, V. (2025) 'Virtual reality and sustainable tourism: reducing travel demand and overtourism.' SSRN Electronic Journal. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5370265 (visited on 06 September 2025).

Steidle, S., Lucash, M., Nasr-Azadani, E. and Smithwick, E. (2023) 'Testing presence, assessing attitudes: Study of a 3D virtual tour in an 'aesthetically challenged' landscape.' *Journal of Environmental Management* 337, 117574. https://doi.org/10.1016/j.jenvman.2023.117574

Su, Z., Lei, B., Lu, D., Lai, S. and Zhang, X. (2024) 'Impact of ecological presence in virtual reality tourism on enhancing tourists' environmentally responsible behaviour.' *Scientific Reports* 14 (1), 5939. https://doi.org/10.1038/s41598-024-56615-z

Theocharis, D. and Tsekouropoulos, G. (2025) 'Sustainable consumption and branding for Gen Z: How brand dimensions influence consumer behaviour and adoption of newly launched

technological products.' *Sustainability* 17 (9), 4124. https://doi.org/10.3390/su17094124 (visited on 12 August 2025).

Tussyadiah, I. P., Wang, D., Jung, T. H. and tom Dieck, M. C. (2018) 'Virtual reality, presence, and attitude change: Empirical evidence from tourism.' *Tourism Management* 66, 140–154.

UN DESA (2023) *World Population Prospects 2022*. United Nations Department of Economic and Social Affairs. https://population.un.org/wpp (visited on: 12 August 2025).

USGS (2022) *Fifty Years of Landsat Observing Global Forests Above the Canopy*. United States Geological Survey. https://www.usgs.gov/news/featured-story/fifty-years-landsat-observing-global-forests-above-canopy (visited on: 12 August 2025).

World Economic Forum (2023) *Mapping the World's Forests: How Much Nature Do We Have Left?* https://www.weforum.org/stories/2023/01/mapping-worlds-forests-green-globe-climate-change/ (visited on: 12 August 2025).

World Resources Institute (2024) *Global Forest Review*. https://www.wri.org/forests (visited on 12 August 2025).

Yung, R. and Khoo-Lattimore, C. (2019) 'New realities: A systematic literature review on virtual reality and augmented reality in tourism research.' *Current Issues in Tourism* 22 (17), 2056–2081. https://doi.org/10.1080/13683500.2017.1417359

Zhang, Z.-H. and H.-C. Huang (2025) 'Enhancing sustainable tourism through virtual reality: The role of collectable experiences in well-being and meaning in life.' Sustainability 17(13), 5809. https://doi.org/10.3390/su17135809 (visited on 22 September 2025).

Zhu, Y., Li, J., Han, X., Wang, R., Wang, C. and Pu, C. (2025) 'Embracing the future: Perceived value, technology optimism and VR tourism behavioural outcomes among Generation Z.' International Journal of Human–Computer Interaction 41 (4), 2337–2351. https://doi.org/10.1080/10447318.2024.2322203