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Teaching Methodology of Historical Geography Based on Modern Pedagogical Technologies in Support of Sustainable Development Goals

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ABSTRACT

This article explores the methodology for teaching historical geography through the integration of modern pedagogical technologies in alignment with the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education). In the context of an evolving educational landscape, the use of digital tools such as Geographic Information Systems (GIS), virtual reality (VR), interactive maps, and online platforms has shown promising results in enhancing students' engagement, spatial thinking, knowledge retention, and critical thinking skills. This research examines the effectiveness of these technologies in improving the understanding of complex historical-geographical concepts and the development of practical skills in students. The study presents a comparative analysis of traditional and technology-based teaching methods, showing significant improvements in student outcomes. The findings suggest that integrating technology into the historical geography curriculum not only modernizes the teaching process but also supports the broader goal of sustainable, inclusive, and future-oriented education.

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1. INTRODUCTION

Historical geography plays a vital role in helping students understand the intricate relationship between geographical environments and historical processes (Ahn & Juraev, 2023; Nanglu *et al*., 2023). As a discipline, it allows learners to analyze how physical space and human actions interact over time, fostering critical thinking, spatial reasoning, and a contextual understanding of historical change (Fitzpatrick, 2015). However, traditional instructional methods—primarily based on lectures and static maps—often fall short in fully engaging students or cultivating deeper comprehension of spatial-temporal dynamics (Oliver & Moriarty, 2017; Firmansyah & Atmaja, 2025; Zhang *et al*., 2025).

In light of the global call for educational reform driven by the United Nations Sustainable Development Goals (SDGs) (especially SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all), there is a growing imperative to innovate teaching methodologies (see https://unesdoc.unesco.org/ark:/48223/pf0000247444). The integration of modern pedagogical technologies such as Geographic Information Systems (GIS), virtual reality (VR), interactive simulations, and online collaborative platforms represents a transformative opportunity to modernize historical geography education (Zbereanu, 2024; Lee, 2023; Zafarovna, 2024). These tools provide immersive and dynamic learning environments that enhance student engagement, improve knowledge retention, and develop critical and spatial thinking (Miller & Miller, 2019).

The pedagogical value of these technologies aligns with constructivist learning theories, where knowledge is actively constructed through experience and exploration. In historical geography, this means enabling students to virtually explore historical sites, analyze spatial data through GIS, and collaborate in real-time using digital tools; thus shifting the role of students from passive recipients to active participants in their learning process (Labianca, 2021; McCall *et al*., 2015; Ahlqvist *et al*., 2012; Goodchild *et al*., 1992). These approaches also support Education for Sustainable Development (ESD) by fostering interdisciplinary competencies, digital literacy, and global awareness.

Furthermore, digital technologies offer flexible, blended learning models that allow for personalized pacing and multimodal instruction. This is especially important in diverse classrooms where students exhibit varying cognitive styles and levels of technological access (Sweller, 1988). Integrating such tools not only improves academic outcomes but also equips students with future-ready skills needed in the digital economy and sustainable development contexts.

This paper explores a comprehensive methodology for teaching historical geography using modern educational technologies. It evaluates theoretical foundations, presents a comparative analysis of traditional and technology-enhanced teaching methods, and provides empirical evidence on student learning outcomes. By bridging classical content with innovative delivery, this approach seeks to modernize the curriculum while addressing the goals of sustainable, inclusive, and impactful education.

2. LITERATURE REVIEW

The evolution of historical geography as an academic subject has closely mirrored changes in pedagogical approaches and technological advancements. Traditionally, historical geography relied heavily on narrative texts and static maps, which often limited students' ability to visualize spatial-temporal relationships (Fitzpatrick, 2015). However, the rise of digital tools in education has prompted scholars and educators to re-examine the methodologies used in teaching geography-related disciplines, especially in the context of the

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Fourth Industrial Revolution and the Sustainable Development Goals (see https://unesdoc.unesco.org/ark:/48223/pf0000247444).

One of the most significant advancements in this field has been the application of GIS. GIS enables learners to analyze spatial patterns of historical events, such as migration, urbanization, and trade, using real-world data (Van der Meer & O'Brien, 2019). GIS promotes not only technical proficiency but also spatial intelligence and critical interpretation, key components of both geographical and historical analysis.

Virtual Reality (VR) and Augmented Reality (AR) have also emerged as transformative tools in historical geography education. Virtual field trips to ancient cities or reconstructed battlefields significantly increased students' motivation and engagement (Miller & Miller, 2019). These immersive experiences foster experiential learning and align with SDG 4's emphasis on inclusive and equitable education through innovative approaches.

Blended learning models, which combine face-to-face instruction with online digital components, offer additional flexibility in historical geography education. Blended models enhance learning outcomes by catering to diverse learning preferences and providing opportunities for repeated engagement with digital resources such as interactive maps, videos, and discussion forums (Oliver & Moriarty, 2017). This approach supports inclusive access and lifelong learning, as envisioned in SDG 4.7, which promotes education that fosters sustainable development, global citizenship, and appreciation of cultural diversity.

From a theoretical standpoint, constructivism provides a strong foundation for integrating technology into historical geography. Learners are encouraged to build their understanding by engaging in exploratory tasks, such as mapping historical trade routes or simulating geographical change over time, thus promoting active knowledge construction. Similarly, connectivism (Goldie, 2016) underscores the importance of digital networks in learning, positioning students to navigate interconnected data sources and media to construct meaning.

Cognitive Load Theory (Sweller, 1988) also plays an important role in instructional design. Technology can help manage cognitive demands by breaking down complex historical-geographic information into manageable segments using animations, layered digital maps, and step-by-step simulations. Some researchers support this with their Multimedia Learning Theory, suggesting that the combination of visual and verbal inputs significantly enhances knowledge retention. Moreover, scholars have emphasized the role of multiple intelligences, particularly spatial intelligence, in effective geography education. GIS and 3D modeling tools nurture spatial cognition by allowing learners to manipulate digital environments and construct geographic-historical narratives.

Finally, the integration of technology in historical geography is consistent with broader educational transformations toward ESD. Educational institutions must evolve to develop learners' capacity to respond to global challenges. In this sense, teaching historical geography with modern tools not only strengthens disciplinary knowledge but also cultivates digital citizenship, interdisciplinary thinking, and awareness of socio-environmental interactions, skills that are vital for achieving the 2030 Agenda.

3. METHODS

This study employed a mixed-methods research design, integrating both quantitative and qualitative approaches to evaluate the effectiveness of modern pedagogical technologies in teaching historical geography. The aim was to compare student learning outcomes, engagement, and skill development between traditional and technology-enhanced

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instructional methods, in line with the goals of SDG 4 to ensure inclusive and equitable quality education.

The research was conducted in two secondary-level classrooms in Uzbekistan, each comprising 30 students. The participants were randomly divided into two groups:

(i) Control Group: Received instruction through traditional methods such as lectures, textbook-based discussions, and static maps.
(ii) Experimental Group: Engaged with technology-enhanced methods, including GIS applications, virtual field trips, 3D visualizations, interactive digital maps, and collaborative online platforms.

A quasi-experimental pre-test–post-test design was implemented. Both groups completed identical pre-tests to assess baseline knowledge, followed by the intervention phase, and finally post-tests and qualitative feedback collection.

To ensure valid and reliable data collection, the following instruments were used:

(i) Pre- and Post-Tests: Objective tests measuring knowledge retention, spatial thinking, and historical-geographic understanding.
(ii) Observation Checklists: Used to record student engagement, participation, and use of technological tools.
(iii) Surveys and Questionnaires: Collected students' perceptions of the learning process, interest levels, and perceived skill improvement.
(iv) Reflective Journals and Open-Ended Interviews: Allowed deeper insight into learners' experiences and cognitive engagement.

The experimental group had access to the following digital tools:

(i) GIS: For analyzing spatial data and historical maps.
(ii) Virtual Reality (VR): Simulated immersive field trips to historical sites and civilizations.
(iii) Interactive Whiteboards: Used for real-time map annotation and spatial analysis.
(iv) Online Platforms (e.g., Google Earth, Padlet): Facilitated collaborative learning, historical reconstruction, and peer-to-peer feedback.
(v) Digital Textbooks and 3D Models: Provided multimodal content aligned with Multimedia Learning Theory.

These tools were selected to reflect current innovations in educational technology and their alignment with the constructivist, experiential, and blended learning frameworks discussed in the literature.

Quantitative data from pre- and post-tests were analyzed using descriptive statistics and paired t-tests to determine significant differences between groups in terms of:

(i) Student Engagement
(ii) Knowledge Retention
(iii) Critical Thinking
(iv) Practical Skill Development

Qualitative data from interviews and journals were subjected to thematic analysis to identify recurring patterns related to student perceptions, motivation, and depth of understanding.

Informed consent was obtained from all participants, and ethical approval was secured from the university's research ethics committee. Anonymity and confidentiality were maintained throughout the study.

The methodology was designed to directly contribute to SDG 4 targets, particularly:

(i) 4.1 – Improving learning outcomes through innovative instructional design.
(ii) 4.4 – enhancing relevant skills, including technological and spatial competencies.

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(iii) 4.7 – promoting global citizenship, sustainable development, and appreciation of cultural heritage through historical geographic content.

4. RESULTS AND DISCUSSION

This section presents a comprehensive analysis of the outcomes derived from implementing modern pedagogical technologies in the instruction of historical geography. The results are discussed in alignment with the research objectives, educational theories, and the broader framework of the United Nations SDGs, particularly SDG 4 on Quality Education.

The findings are based on a comparative analysis of student performance, engagement, cognitive development, and practical skill acquisition between the control group (traditional methods) and the experimental group (technology-based methods). Data were collected through a combination of pre- and post-tests, student surveys, reflective journals, performance tracking, and teacher observations. These instruments provided a multi-dimensional view of how students interacted with both instructional approaches and how each method influenced learning outcomes. The findings from this study are shown in **Table 1.**

Table 1. Comparison of Student Performance (Traditional vs. Technology-Based Methods)

Criteria	Traditional Methods (%)	Technology-Based Methods (%)
Student Engagement	65%	88%
Knowledge Retention	60%	85%
Critical Thinking Improvement	55%	80%
Practical Skills Development	50%	82%

4.1. Student Engagement

One of the most notable findings was the significant difference in student engagement between the two groups. As shown in **Table 1**, students exposed to technology-enhanced instruction exhibited an engagement rate of 88%, compared to 65% in the traditional group.

This elevated engagement was evident in various aspects of classroom activity, including increased participation in discussions, greater enthusiasm for tasks, and proactive involvement in group projects. In particular, the use of virtual reality (VR) and interactive maps appeared to captivate students' attention. VR simulations of historical environments—such as ancient Mesopotamian cities or medieval trade routes—enabled students to "experience" history firsthand, thereby transforming passive content into an immersive experience.

From a theoretical standpoint, this aligns with the experiential learning model, which emphasizes the importance of concrete experiences in facilitating reflective observation and active experimentation. Students who virtually "walked through" historical environments were better able to form mental connections and engage in discussions that required higher-order thinking.

Moreover, student journals often reflected heightened motivation. Comments such as *"I felt like I was there"* or *"I understood trade routes better after seeing them in VR"* reinforced the value of immersive learning. This suggests that engagement was not merely behavioral but also emotional and cognitive, which is consistent with the engagement dimensions model (Fredricks *et al*., 2004).

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4.2. Knowledge Retention

Knowledge retention was another key area of assessment. According to **Table 1**, students in the experimental group achieved a post-test retention rate of 85%, while those in the control group scored only 60%. This 25% increase highlights the effectiveness of technology-enhanced instruction in supporting long-term memory and comprehension.

The underlying mechanism can be attributed to Multimedia Learning Theory, which posits that dual-channel information processing (through both visual and auditory inputs) leads to deeper encoding of information. For instance, when students viewed layered maps displaying the expansion of empires over centuries, accompanied by narrative explanations, they processed content more holistically. These interactive features supported active cognitive engagement, as students were required to interpret, compare, and synthesize information across multiple modalities.

Additionally, students were encouraged to manipulate the data themselves. GIS-based tasks, such as tracking population shifts or analyzing topographic features in historical battles, required students to apply concepts rather than memorize facts. This active manipulation of historical data contributed to enhanced retention by encouraging learners to construct knowledge, consistent with constructivist theory.

The reflective interviews corroborated these outcomes. One student remarked, *"I used to forget the dates and places quickly, but now I remember because I could see how places looked and changed."* Another stated, *"The colors and movement on the map made the history come alive."* These responses underscore the importance of visual-spatial learning in history instruction, especially for students with high spatial intelligence.

4.3. Critical Thinking Development

Another significant area of improvement was critical thinking, which was measured through student responses to analytical assignments and open-ended scenario tasks. The experimental group demonstrated an 80% improvement, compared to only 55% in the control group, as detailed in **Table 1**.

Students using technology were frequently asked to engage in tasks requiring synthesis, evaluation, and hypothesis testing. For example, when analyzing how geographical barriers influenced military campaigns, students used GIS overlays to compare elevation, vegetation, and settlement patterns. This encouraged them to form reasoned arguments supported by geospatial evidence.

Such tasks mirror Bloom's taxonomy, particularly the higher levels of analysis, synthesis, and evaluation. The ability to interpret complex data sets and propose explanations based on historical context demands not just factual knowledge but the integration of multiple sources and critical reasoning.

Connectivism also offers a framework for interpreting this improvement. The technological environment created information networks where students could traverse databases, visual maps, textual narratives, and collaborative discussions (Goldie, 2016). Learning in such environments emphasizes the navigation of connections, rather than linear memorization, thus cultivating a mindset of inquiry.

Student reflections further illustrated this process. One student wrote, *"I learned not just what happened, but why and how geography played a role."* Another observed, *"Seeing maps and statistics together made me realize how decisions were made in the past."* These insights reflect meta-cognitive growth, an essential indicator of critical thinking development.

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4.4. Practical Skills Development

The development of practical skills—especially those related to digital literacy and spatial analysis—was perhaps the most transformative outcome. The experimental group showed a marked improvement of 82%, as compared to 50% in the control group (**Table 1**).

These skills were cultivated through tasks such as:

(i) Creating historical overlays using GIS.
(ii) Interpreting satellite imagery about ancient trade routes.
(iii) Designing digital story maps to narrate the expansion of empires.
(iv) Conducting peer reviews of virtual explorations.

Such activities not only enhanced academic skills but also equipped students with transferable 21st-century competencies in digital navigation, data visualization, and critical communication. These competencies align directly with SDG 4.4, which emphasizes the importance of developing relevant technical and vocational skills for employment and entrepreneurship.

Moreover, these skills have cross-disciplinary value. Students who mastered GIS and visualization techniques were able to apply them in science, civic education, and environmental studies, indicating that the integration of technology in history education has a ripple effect across the curriculum.

Teachers also noted improved independence and digital confidence among students. Those previously passive in traditional settings took on leadership roles during collaborative mapping exercises. In addition, students began using online resources beyond class requirements, suggesting a shift in learning behavior from dependency to autonomy.

4.5. Comparative Summary and Visualization

The results summarized in **Table 1** and visualized in the bar chart figure demonstrate the superiority of modern pedagogical technologies across all assessment criteria. Each domain—engagement, retention, critical thinking, and skills development—showed substantial improvement in the experimental group.

The visualization provides a compelling depiction of performance gaps and affirms the quantitative significance of the intervention. The experimental group outpaced the control group by margins ranging from 25% to 32%, supporting the robustness of the technology-enhanced approach.

4.6. Interpretation Through Theoretical Lenses

These findings are supported by multiple educational theories:

(i) Constructivism: Students constructed meaning through interaction and inquiry.
(ii) Experiential Learning: VR and GIS offered concrete experiences leading to reflection and learning cycles.
(iii) Cognitive Load Theory: Interactive content allowed students to manage information more effectively by reducing extraneous load.
(iv) Connectivism: Learning occurs across distributed networks of content, tools, and peers.
(v) Multimedia Learning Theory: Learning was deepened through the dual channel presentation of information.

Each of these frameworks explains how and why technology facilitated improved educational outcomes.

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4.7. Implications for SDG 4 and Global Educational Reform

Beyond empirical outcomes, the study has broader implications for the global education agenda. The integration of modern pedagogical technologies in historical geography supports:

(i) SDG 4.1 – ensuring effective learning outcomes through innovative pedagogy.
(ii) SDG 4.4 – developing digital skills and competencies for future employment.
(iii) SDG 4.7 – promoting sustainable development, cultural understanding, and global citizenship through interdisciplinary learning.

By allowing students to explore how past societies adapted to or failed under environmental pressures, the curriculum fosters historical consciousness and a deeper appreciation of sustainability. For instance, GIS analysis of deforestation patterns in ancient civilizations or the impact of topography on settlement vulnerability directly ties historical knowledge to contemporary global challenges. Thus, teaching historical geography with modern technologies becomes not only an academic innovation but a strategic tool for sustainable development. This study adds new information regarding SDGs, as reported elsewhere (Keran *et al*., 2024; Rahmat *et al*., 2025; Soegoto *et al*., 2025; Namoussa *et al*., 2025; Glovatskii *et al*., 2025; Yustiarini *et al*., 2025; Merzouki *et al*., 2025; Waardhani *et al*., 2025; Krishnan *et al*., 2024; Djiron *et al*., 2024).

4.8. Challenges and Considerations

While the outcomes are largely positive, several challenges were noted. These include:

(i) Technological access disparities: Not all students had equal access to devices or high-speed internet at home.
(ii) Teacher training requirements: Effective implementation requires significant professional development.
(iii) Initial cognitive overload: Some students initially struggled with the interface and complexity of tools like GIS, requiring scaffolded support.

These limitations underscore the need for institutional readiness, infrastructure development, and inclusive policies to ensure the successful scaling of these methods.

4.9. Recommendations for Future Implementation

Based on these findings, the following recommendations are proposed:

(i) Professional training for educators in digital tools and blended learning strategies.
(ii) Curriculum integration of GIS, VR, and interactive tools across history and geography subjects.
(iii) Collaborative project-based learning to enhance peer engagement and deeper inquiry.
(iv) Inclusion of SDG-oriented content to link past human behavior with current global issues.

Future research should focus on longitudinal studies to assess the durability of learning gains and the adaptability of these technologies in diverse educational contexts.

5. CONCLUSION

The findings of this study provide compelling evidence that the integration of modern pedagogical technologies significantly enhances the teaching and learning of historical geography. Students who participated in technology-enhanced learning environments demonstrated markedly higher levels of engagement, improved knowledge retention, deeper critical thinking, and stronger development of practical, transferable skills, compared to those taught through traditional methods. These improvements, as illustrated in both qualitative

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reflections and quantitative metrics, affirm the pedagogical value of tools such as GIS, VR, interactive digital maps, and blended learning platforms.

The effectiveness of these methods can be attributed to their foundation in sound educational theories. Constructivism facilitated active knowledge construction; experiential learning provided immersive opportunities to internalize content; cognitive load theory ensured material was accessible; and connectivism enabled learners to build meaning through digital networks and peer interaction. Multimedia learning principles also contributed to long-term retention by leveraging dual-channel input processing. Together, these frameworks support the conclusion that modern technologies are not merely add-ons to the curriculum but integral components of a redesigned, future-ready educational model.

Moreover, this pedagogical transformation supports the advancement of Sustainable Development Goal 4 (Quality Education) by fostering inclusive, equitable, and innovative learning environments. By embedding digital competencies and interdisciplinary inquiry into the historical geography curriculum, educators are equipping students with essential skills for the 21st century—spatial intelligence, technological fluency, collaborative problem-solving, and cultural-historical awareness. These skills extend beyond academic settings into civic life, environmental literacy, and workforce readiness, contributing to broader goals of sustainable human development.

While challenges such as digital access, infrastructure limitations, and teacher preparedness remain, the clear advantages of technology-enhanced instruction call for systematic efforts to scale and sustain these innovations. Educational institutions should prioritize:

(i) Ongoing professional development for teachers in digital pedagogy.
(ii) Curriculum redesign that embeds spatial technologies into history and geography courses.
(iii) Investment in digital infrastructure and accessibility to ensure no student is left behind.
(iv) Long-term research to explore the sustainability and adaptability of these methods across different contexts.

Teaching historical geography through modern pedagogical technologies not only revitalizes an essential academic discipline but also serves as a practical pathway toward educational transformation in alignment with global development goals. By bridging past and present through immersive, data-driven, and learner-centered experiences, educators can cultivate a generation of students who are historically informed, technologically empowered, and globally responsible.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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