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Geo-Immersive Learning: A Design Thinking Approach to Virtual Reality for Analyzing Multicultural Social Spaces

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ABSTRACT

Visualizing abstract concepts in Human Geography is challenging, and current Virtual Reality (VR) applications primarily address physical phenomena rather than social dynamics. To bridge this gap, this study aims to develop and evaluate VR-based learning media for the "Population Dynamics and Social Groups" material. The research employs a Research and Development (R&D) design using the Design Thinking model, which consists of five stages: Empathize, Define, Ideate, Prototype, and Test. The development process emphasizes the novelty of integrating technical geospatial data, specifically astronomical coordinates and elevation, with a sociological analysis of three multicultural landscapes in Malang City: Chinatown (Pecinan), the Arab Quarter (Embong Arab), and the Madurese settlement. The subject of the implementation was undergraduate students of Geography Education at Universitas Negeri Malang. Data were collected using expert validation sheets and implementation observation sheets, then analyzed using descriptive quantitative techniques. The results demonstrate that the developed VR media is highly feasible for learning purposes. The quantitative analysis from the field implementation yielded an average observation score of 62.5 (out of a maximum of 68), classifying the product into the "Very Suitable" (Category A) category. Furthermore, qualitative observations indicated a significant increase in student enthusiasm and ease of understanding regarding the spatial distribution of social groups. This study concludes that integrating geospatial data with 360-degree visualization effectively bridges the gap between theoretical knowledge and field reality, offering a robust alternative to physical field trips.

A. INTRODUCTION

The rapid advancement of digital technology compels the educational sector to undergo a transformation through the integration of Information and Communication Technology (ICT). This integration is a critical urgency in creating an immersive and interactive learning ecosystem to respond to the demands of 21st-century competencies (Putra et al., 2023). This phenomenon precipitates a shift in the pedagogical paradigm, a transition from conventional, teacher-centered approaches towards technology-facilitated experiential learning (Putra et al., 2023). Within this paradigm, technology

functions as a catalyst, enabling students to transform abstract knowledge into concrete experiences, thereby enhancing cognitive engagement and the retention of understanding (Masruroh et al., 2024).

The necessity for transforming the learning experience is particularly pivotal within the discipline of geography, specifically regarding the material on "Population Dynamics and Social Groups". This subject demands student competence in comprehending the interaction between humans and their environment, as well as analyzing the manifestation of social elements within physical space (Fadjarajani et al., 2024). A pertinent case study involves ethnic-based settlement patterns, such as the Chinatown (Pecinan) or the Arab Quarter (Embong Arab) in Malang City, which possess distinct sociological characteristics and unique spatial layouts (Luo & Zhang, 2025). However, the complexity of the spatial atmosphere and the cultural nuances inherent in these locations remain abstract and arduous to comprehend if studied solely through textual descriptions.

Furthermore, the challenges of visualizing such complex material have not been adequately addressed by the conventional learning media that currently dominate the classroom. Textbooks and two-dimensional presentations lack the capacity to represent immersive spatial dimensions (Khalidy et al., 2023), consequently causing students difficulty in constructing accurate spatial perceptions (Shen, 2022). Although direct observation methods or field trips are recognized as pedagogical approaches to bridge this issue, their implementation is often impeded by pragmatic factors, including time constraints, high logistical costs, and safety concerns (Masruroh et al., 2024). These issues create a gap between the curricular demands for understanding socio-spatial realities and the limited accessibility students have to the objects of study in a real-world context.

As a solution to overcome accessibility barriers and the limitations of conventional methods, Virtual Reality (VR) technology serves as a "virtual bridge". A primary advantage of VR is its ability to create a "sense of presence", wherein students are not merely passive observers but feel as though they are physically present at the study location with a high degree of realism (Bos, 2022). This feature is crucial for stimulating spatial intelligence. The 360-degree environmental simulation enables students to virtually inhabit the study site, observing architectural morphology and visually and interactively analyzing the unique settlement patterns of the Chinatown and Arab Quarter districts without the need to leave the classroom.

Although VR is proven to provide immersive spatial experiences, the literature review indicates a significant thematic disparity within the field of geography education. The majority of current VR media development tends to be dominated by physical geography phenomena (Gryl, 2022), such as geology and geomorphology (Fahmi et al., 2022; Putra et al., 2023; Putra et al., 2022), oceanography (de Castro et al., 2026), or geomorphological processes (Gielstra et al., 2024; Vandelli et al., 2024). Meanwhile, exploration within the realm of Human Geography, particularly regarding social dynamics grounded in local wisdom and specific settlement case studies, remains relatively limited. The absence of media addressing the complexity of social space results in the underutilization of VR's potential to assist students in comprehending anthropospheric phenomena in their surrounding environment.

Based on the identified research gap in spatial visualization, the objective of this study is to develop and evaluate the feasibility of VR-based learning media for the "Population Dynamics and Social Groups" material. The novelty of this research lies in integrating technical geospatial data with sociological analysis of specific multicultural landscapes in

Malang City (Chinatown, Madura settlement, and the Arab Quarter) to facilitate students' contextual understanding of socio-geographical realities.

B. METHODS

1. Research Design

This research is a type of Research and Development (R&D) aimed at producing a Virtual Reality (VR)-based learning media product. The development model employs a Design Thinking approach, as it involves a deep understanding of user needs, creativity in designing solutions, and a continuous iterative process (Cahyani et al., 2024). Furthermore, this approach places the user at the center of the design process (user-centered) to ensure the functionality and relevance of the final product.

2. Development Procedures

The implementation procedure of Design Thinking consists of five stages, (1) empathize, (2) define, (3) ideate, (4) prototype, and (5) test.

The Empathize stage aims to comprehend the challenges encountered by students. Analysis results indicate that students experience difficulties in visualizing abstract social geography concepts, particularly concerning the spatial atmosphere of a region. Furthermore, observation results demonstrate that conventional classroom methods have not yet been able to deliver a profound spatial experience. Consequently, there is an urgent need for immersive learning media as an alternative to field trips, which are often constrained by logistical issues.

In this stage, the researcher established the instructional and technical specifications of the product. Based on curriculum analysis, the material focuses on "Population Dynamics and Social Groups", utilizing case studies of the Chinatown (Pecinan), Madura, and Arab Quarter (Embong Arab) areas in Malang. The Course Learning Outcomes (CPMK) were formulated to ensure students are capable of understanding the constituent elements of social groups. Technically, the media was defined to include 360-degree panoramic view features, geospatial data integration, and interactive multimedia to support visual learning styles.

The Ideate stage focuses on the structural planning and design of the media, which includes creating the application navigation flow (flowchart) to ensure user-friendliness. Sketches or wireframes were created to design the layout of navigation buttons, sidebar menus, and information windows (pop-ups). The researcher also compiled a storyboard to guide the video content scenarios and text narration to be embedded at each interaction point (hotspot).

The Prototype stage constitutes the development process or the realization of ideas into a product. The production process commenced with the acquisition of 360-degree images (spherical images) at study locations, such as the Eng An Kiong Temple (Chinatown) and the Al-Huda Mosque (Arab Quarter). Technical data integration, in the form of coordinates and elevation, was incorporated into the "Location Tools" feature. The final phase of this process involved the assembly of all visual assets, audio, textual material, and interactive features using VR development software, namely 3DVista Virtual Tour Pro, resulting in an application ready for testing.

The product validation involved two experts in total, comprising one Geography Subject Matter Expert (qualified with a minimum master's degree and >5 years of teaching experience) and one Instructional Media Expert (qualified in educational technology). The instruments utilized a Likert scale; their content validity was established through expert judgment, and reliability was confirmed via a Cronbach's Alpha coefficient of 0.80, ensuring valid and consistent measurement.

3. Research Subjects

The subjects of the research trial were undergraduate students of the Geography Education program at Universitas Negeri Malang who were enrolled in the "Social and Cultural Geography" course, specifically in Class Offering A. The selection of these subjects was conducted using a purposive sampling technique. This method was chosen based on the consideration that the students' characteristics were relevant to the media development objectives; specifically, they were currently studying the material on the classification of constituent elements of social groups.

4. Data Collection Instruments

The instruments utilized to collect data regarding the feasibility and effectiveness of the product in this study consist of two types of non-test instruments, namely:

Expert Validation

This instrument is employed during the validation stage to assess product feasibility prior to field testing. It comprises validation sheets for subject matter experts and media experts. The subject matter validation assesses the alignment of the material with the Course Learning Outcomes (CPMK), the accuracy of geographical concepts, the depth of the case study analysis (Chinatown, Madura, and the Arab Quarter), and linguistic appropriateness. Meanwhile, the media expert validation evaluates the user interface (UI) design, ease of navigation, quality of 360-degree visuals, and the functionality of interactive features.

Implementation Observation

This instrument is used during the product trial stage to obtain quantified qualitative data regarding user responses. The observation sheet is completed by observers while the learning process is in progress. The aspects assessed in this sheet include user response to the media and learning implementation. User response to the media encompasses assessments of interest, enthusiasm, and the ease with which students operate the VR features. Learning implementation focuses on the assessment of observable indicators of understanding, active discussion, and student-lecturer interaction while using the media. Assessment scores utilize a 1-4 Likert scale to generate quantitative data, which is subsequently converted into feasibility categories.

5. Data Analysis

The assessment data obtained from subject matter experts, media experts, and field observers using a 1-4 Likert scale were analyzed by aggregating the scores. Furthermore, to determine the feasibility or suitability category, class interval analysis was employed. The formula used to determine the interval range (i) is as follows:

$$i = \frac{Maximum\ score - Minimum\ score}{Number\ of\ class\ intervals}$$

Where:
Maximum score: Number of question items × highest score (4)
Minimum score:: Number of question items × lowest score (1)
Number of class intervals: 4 (very suitable, suitable, less suitable, and unsuitable)

Based on the interval calculation, the feasibility level of the media and the implementation of learning were classified into four categories, adapted from Nuryadi et al. (2017): (1) Very suitable / very feasible, (2) Suitable / feasible, (3) Less suitable / quite feasible, and (4) Unsuitable / less feasible,

C. RESULT AND DISCUSSION

1. Development of VR Edu-Geography Media (Ideate & Prototype Phase)

Based on the storyboard and flowchart designs constructed during the ideation phase, the development process proceeded to the prototyping phase utilizing 3DVista software. The selection of this platform was predicated on its capability to integrate 360-degree panoramic assets with interactive multimedia elements without necessitating complex coding. The final output of the development is a web-based application accessible via both PC and mobile devices, thereby facilitating flexible access for students.

The main User Interface (UI) was designed with a minimalist yet informative approach to facilitate user navigation. As illustrated in Figure 1, the main display presents a 360-degree panoramic visual (spherical view) that enables students to explore the physical environment of the case study locations, in this instance, the Chinatown (Pecinan), Madura settlement, and Arab Quarter (Embong Arab) areas, immersively. The primary navigation system is situated on a sidebar on the left side of the screen, containing a hierarchical menu that includes: CPMK & Sub-CPMK, Material Introduction, Case Study Destinations (Chinatown, Arab Quarter, Madura), Assignments, and References. Users can navigate between locations or scenes using interactive arrow-shaped hotspots integrated directly into the street visuals.

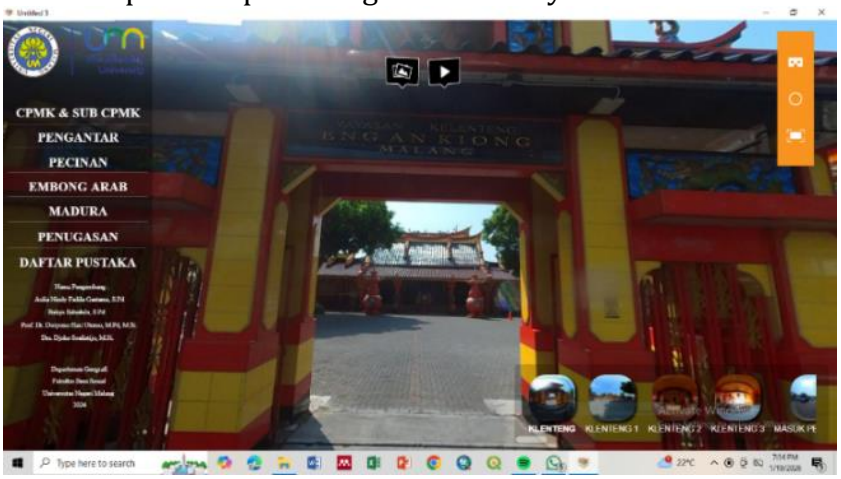
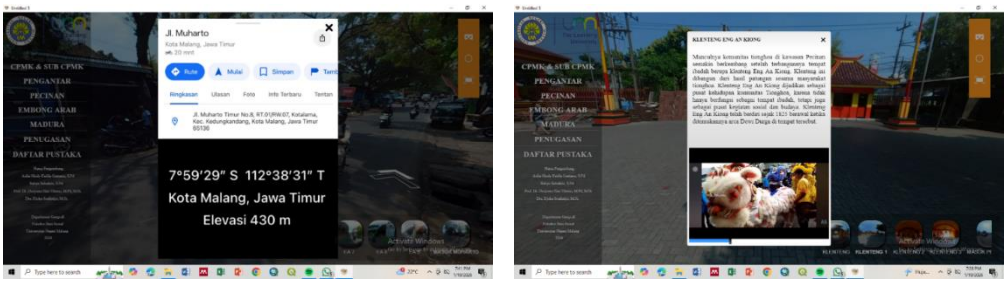


Figure 1. Main Interface of VR Media
Source: Researcher's Documentation (2026)

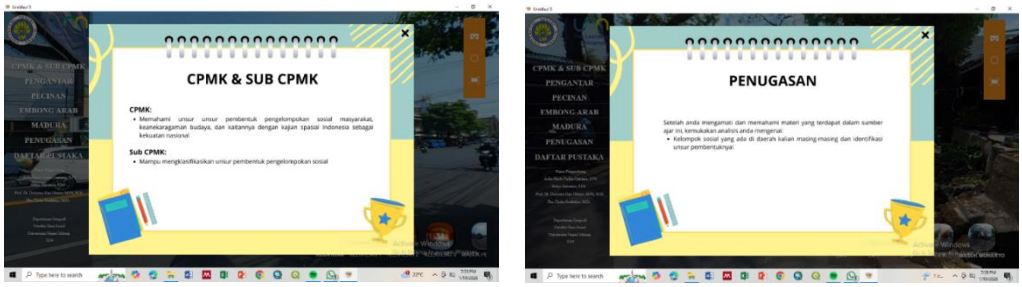
One of the distinct features distinguishing this media from conventional virtual tours is the integration of technical geospatial data. As shown in Figure 2a, the "Location Tools" feature presents precise astronomical coordinate data (e.g., 7°59'29"S 112°38'31"E) and elevation information (altitude 430 masl) of the location being observed. This feature is crucial for supporting students' spatial analysis capabilities. Furthermore, the media is enriched with Pop-up Information containing historical-sociological narratives and embedded documentary videos, such as the Barongsai performance video at Eng An Kiong Temple (Figure 2b), to reinforce students' contextual understanding of local cultural dynamics.



(a) (b)

Figure 2. Interactive Features of the VR Media: (a) Integration of Geospatial Data (Coordinates and Elevation) in the "Location Tools", and (b) "Pop-up Information" Displaying Cultural Narratives and Embedded Videos
Source: Researcher's Documentation (2026)

To ensure the achievement of learning objectives, this media is equipped with a structured instructional menu. Prior to exploration, students are presented with information regarding Course Learning Outcomes (CPMK) and introductory material defining social groups (Figure 3a). Following the virtual observation, students are directed to the "Assignment" menu (Figure 3b), which contains instructions to analyze social groups in their respective regions based on the understanding acquired from the VR simulation. This sequence is designed to stimulate Higher Order Thinking Skills (HOTS) through a comparative study between the virtual simulation and reality in the students' own environments.



(a) (b)

Figure 3. Structured Instructional Menus: (a) Displaying Course Learning Outcomes (CPMK) and Introductory Material , and (b) The "Assignment" Interface for Student Analysis Tasks.
Source: Researcher's Documentation (2026)

2. Implementation Results (Test Phase)

The testing phase was executed through two primary mechanisms: product revision based on preliminary testing and quantitative data measurement during field implementation.

Prior to implementation in the large class, the VR media prototype underwent a refinement phase based on feedback from limited trials. Table 2 summarizes the substantial improvements made to enhance the instructional quality of the media. Key improvements encompassed the addition of textual description features to every visual element (photo/video) to clarify the informational context, and the alignment of assignment instruments to be more measurable in accordance with the established CPMK and Sub-CPMK indicators.

Table 2. Summary of Product Revisions Based on Preliminary Testing

No	Before Revision	After Revision
1.	 Visual elements (photos/videos) lacked explanatory descriptions.	 Explanatory textual descriptions added to all photos and videos
2.	 Assignments were not aligned with CPMK and Sub-CPMK indicators.	 Assignments explicitly aligned with CPMK and Sub-CPMK indicators.

Source: Research Data Analysis (2026)

The product implementation was conducted with Undergraduate Geography Education students, involving two observers to assess the execution of learning and user response using observation sheets. The quantitative data resulting from the assessments by both observers are presented in Table 3.

Table 3. Detailed Results of Field Implementation Observation

Observed Aspects	Max Score	Observer 1 Score	Observer 2 Score	Average Score	Category
Media Usability & Technical Quality	24	21	23	22.0	Very Suitable
Student Engagement	20	18	19	18.5	Very Suitable
Instructional Effectiveness	24	22	22	22.0	Very Suitable
All Aspects	**68**	**61**	**64**	**62.5**	**Very Suitable**

Source: Research Data Analysis (2026)

Based on the data in Table 3, Observer 1 assigned a total score of 61, and Observer 2 assigned a total score of 64 out of a maximum score of 68. The calculated average score of 62.5 indicates that this value falls within the interval range of $X > 55.25$ (based on the interval formula i=12.75). Consequently, the implementation of this VR-based learning media falls into the "Very Suitable" or Very Feasible category. This finding is further evidenced by the high performance across all observed aspects. As detailed in the table, the aspects of Media Usability & Technical Quality and Instructional Effectiveness both achieved a high average score of 22.0 (out of 24), indicating that the material is presented clearly and the technology functions reliably. Furthermore, the Student Engagement aspect obtained an average score of 18.5 (out of 20), which confirms that the developed media is effective in stimulating student enthusiasm and creating a conducive, interactive learning environment.

3. Discussion

The implementation results indicate that the developed VR media achieved the "Very Suitable" feasibility category, accompanied by significant positive responses from users. The high scores in the aspects of student enthusiasm and engagement during learning can be attributed to the unique characteristic of VR technology in creating a Sense of Presence. In the context of the Chinatown (Pecinan) and Arab Quarter (Embong Arab) case studies, the 360-degree panoramic feature successfully eliminates the physical distance between the classroom and the object of study. Students are not merely passive observers viewing two-dimensional images, they experience a sensation of virtual presence at the location (Putra et al., 2023). This aligns with immersive learning theory, which states that an increased sense of presence correlates positively with students' intrinsic motivation and emotional engagement with the learning material (Shen, 2022).

Beyond the affective aspect, the effectiveness of the media in facilitating material comprehension, can be explained through the theories of Spatial Visualization and Contextual Learning. The "Social Group Dynamics" material, which was originally abstract and textual, has been successfully concretized through spatial visualization (Kühne & Edler, 2022). The integration of geospatial data features, such as coordinates and elevation in the "Location Tools" menu, assists students in constructing an accurate spatial mental map (Purwanto & Mellyana, 2024). By directly observing the architecture and spatial layout of the Madurese or Chinatown communities virtually, students can link sociological theories with physical evidence in the field (situated learning), thereby making the cognitive process more effective compared to conventional lecture methods.

The findings of this research also offer a new perspective compared to previous trends in geography VR media development. While the majority of prior studies have tended to focus on visualizing physical geography phenomena, this research demonstrates that VR is also highly relevant for Human Geography (Bos et al., 2021; Huang & Hu, 2025; Roelofsen, 2022). The novelty of this study lies in the integration of technical geospatial data with humanistic-sociological analysis. The use of the 3DVista application, which combines virtual tours with cultural documentary video content, has proven capable of presenting the complexity of human-environment interactions holistically. This confirms that VR technology is capable of bridging the gap between technical spatial analysis and socio-cultural understanding within the geography education curriculum.

Despite the highly positive outcomes, this study acknowledges certain limitations. Technically, the web-based VR media relies heavily on stable internet connectivity and adequate user device specifications (PC or mobile), which may pose accessibility challenges. Additionally, prolonged use of screen-based VR can induce visual fatigue. Methodologically, the implementation was limited to a specific cohort of Geography Education students and focused exclusively on three multicultural landscapes in Malang City. Therefore, future research should involve a broader demographic sample and address technical barriers by optimizing offline access to ensure wider generalizability and accessibility.

D. CONCLUSION AND SUGGESTIONS

Based on the research and development process conducted using the Design Thinking approach, this study successfully produced a Virtual Reality (VR)-based learning media product focusing on "Population Dynamics and Social Groups". This product offers novelty through the integration of 360-degree panoramic visuals of three multicultural case study locations, Chinatown (Pecinan), the Arab Quarter (Embong Arab), and the Madurese settlement, enriched with technical geospatial data and in-depth sociological analysis. The results of the field implementation trial demonstrate that this media is highly feasible for instructional use, evidenced by an average observation score of 62.5, which places it in the "Very Suitable" (Category A) classification. The positive response, indicated by student enthusiasm and ease of understanding, suggests that this VR media effectively bridges the gap in spatial visualization, enabling abstract social geography concepts to be understood more concretely and contextually without being constrained by physical space limitations.

As practical implications and recommendations for future work, several suggestions are proposed for educators and researchers. For educators, this VR media is recommended as a viable alternative to field trips, which are often hindered by logistical constraints, particularly for subjects requiring the observation of social environments. For future researchers, it is suggested to expand the scope of case study locations to diversify the database of social groups, as well as to conduct measurable experimental tests to examine the effectiveness of the media on students' cognitive learning outcomes. Furthermore, technical development should be enhanced through the addition of gamification features or interactive quizzes within the VR environment to maximize user interactivity.

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