Sinergi International Journal of Education
E-ISSN: 2988-4926
Volume. 1, Issue 2, August 2023
Page No: 55-69

Integrating Geospatial Technology in Learning: An Innovation to Improve Understanding of Geography Concepts

Susan E Manakane[1], Philia Christi Latue[1], Heinrich Rakuasa[2]
[12]Universitas Pattimura, Indonesia
[3]Universitas Indonesia, Indonesia
Correspondent: heinrichrakuasa01@gmail.com[3]

Received : May 8, 2023
Accepted : August 18, 2023
Published : August 31, 2023

Citation: Manakane, S, E., Latue, P, C., Rakuasa, H. (2023). Integrating Geospatial Technology in Learning: An Innovation to Improve Understanding of Geography Concepts. Sinergi International Journal of Education, 1(2), 55-69.

ABSTRACT: This research discusses the integration of geospatial technology in geography learning as an innovation to improve students' understanding of geography concepts. This research uses literature study method to investigate the importance of geospatial technology integration in geography learning with the aim of improving students' understanding of geography concepts. The results show improvements in visualization of abstract concepts, introduction of global and local concepts, development of analytical skills, and more active student interaction. Constraints such as facility availability and teacher training were also recognized. The integration of geospatial technology opens up opportunities for more engaging and effective contextualized learning in the digital era.

Keywords: Geography Learning, Geography Concepts, Geospatial Technology.

INTRODUCTION

In the era of globalization and advances in information technology, education is required to continue to innovate in presenting learning materials in a more interesting, effective and contextual manner. One of the branches of science that plays an important role in understanding the relationship between humans and their environment is geography (Manakane, 2011; Purwantara et al., 2023). Geography is no longer just about maps and coordinates, but also involves a deeper understanding of spatial patterns, regional dynamics, and human interaction with the environment (Kolvoord et al., 2019). In this context, geospatial technologies have emerged as innovative tools that have the potential to change the way we teach and understand geography. These technologies include Geographic Information Systems (GIS) and various tools that enable visualization of geographic data in the form of interactive maps and spatial analysis (Curtis, 2019). The integration of geospatial technology in learning can provide students with a deeper and more contextualized understanding of geography concepts.

Geography education has special challenges, especially in explaining abstract and complex concepts such as population migration patterns, ecosystem interactions, and the impacts of climate change (Pearce et al., 2022). This is where geospatial technology comes in. Using this technology, teachers can help students visualize data that was previously difficult to understand in the form of

text or static images (Manakane, 2017). Through interactive maps, students can explore geography concepts in the context of a real region, connecting those concepts to the real world. In addition, geospatial technology's ability to perform spatial analysis allows students to think critically and develop problem-solving skills (Nurida et al., 2022). They can manipulate geographic data, identify patterns, and construct arguments based on the findings of the analysis. This not only enriches students' understanding, but also helps them develop skills that are relevant in the real world.

However, while the potential offered by geospatial technology is promising, successful implementation requires a good understanding of how to integrate it into learning. Teachers need to be trained to use GIS software and understand how to optimize this technology in presenting geography materials (Lee, 2023). In addition, technical challenges such as infrastructure and device accessibility must also be addressed to ensure that all students can benefit. Based on the above background, the research aims to discuss the positive implications of integrating geospatial technology in geography learning (Kenna, 2022). Through a more in-depth analysis of the benefits and challenges of implementing this technology, we can understand how geospatial technology can be a useful innovation in improving the understanding of geography concepts and bringing more engaging and contextualized learning for students.

METHOD

This research uses the literature study method to investigate the importance of geospatial technology integration in geography learning with the aim of improving students' understanding of geography concepts. The literature study method was used because the focus of this research is on the theoretical and contextual analysis of the literature relevant to the topic discussed. The literature selection process was conducted by detailing the inclusion criteria that included literature that addressed the use of geospatial technology in the context of geography education and its impact on the understanding of geography concepts. The literature sources obtained included scientific journals, research articles, books, and academically verified online sources. Data obtained from the literature were analyzed through a comprehensive descriptive approach. An in-depth understanding of how geospatial technology can be integrated in geography learning was explored through a literature review involving related concepts, theories, case studies, and research results. The literature analysis includes the advantages of using geospatial technology, its impact on students' understanding, and its challenges and implications in the educational context.

RESULT AND DISCUSSION

Benefits of Geospatial Technology Integration

The integration of geospatial technology in geography learning has a number of significant benefits. One of them is its ability to transform abstract concepts into visualizations that are moretangible and easy to understand. Students can see patterns of human movement, population distribution, and interactions between humans and the environment in the form of interactive digital maps, which helps internalize concepts better (Kolvoord et al., 2019).

According to Alibrandi & Goldstein, (2015), the benefits of geospatial technology integration in geography learning are diverse and contribute significantly to students' understanding and engagement in learning geographic concepts. One of the main benefits is its ability to transform abstract concepts into visualizations that are more tangible and easily understood. In learning geography, many concepts are difficult to understand through text or oral explanations alone. Geospatial technology, particularly Geographic Information Systems (GIS), allows students to visually depict information in the form of interactive digital maps (Manakane et al., 2023). Through these maps, concepts such as human movement patterns, population distribution, and interactions between humans and the environment can be clearly illustrated, so that students can better internalize the concepts (Sinha et al., 2017).

Visualization of geographic data through geospatial technology also helps students develop a deeper understanding of spatial relationships (Egiebor & Foster, 2019). In geography, it is important to understand how phenomena are interconnected and influenced in different locations. By viewing information in the form of interactive maps, students can understand the spatial distribution of various factors and how the interactions between them form distinctive patterns (Fargher, 2018). In addition, the integration of geospatial technology also encourages students' active involvement in the learning process. In conventional learning, students are often passive recipients of information. However, by using geospatial technology, students can conduct independent exploration of geographic data, create questions and test their own hypotheses. This creates a more interactive learning experience and allows students to take an active role in building their understanding. The utilization of geospatial technology also brings benefits in developing students' analytical skills (Bearman et al., 2016). Through geographic data manipulation and spatial analysis, students can identify distribution patterns, spatial correlations and hotspots. This helps students hone their critical thinking and analytical skills in analyzing geographic information in greater depth (Bearman et al., 2016).

Thus, the integration of geospatial technology in geography learning has great benefits in transforming abstractions into real visualizations, developing an understanding of spatial relationships, encouraging students' active involvement, and developing their analytical skills. In an era where technology is an integral part of everyday life, the utilization of geospatial technology in learning not only sharpens students' learning experience, but also prepares them to face the challenges of an increasingly complex world.

Analytical Skills Development

The utilization of geospatial technology also encourages the development of students' analytical skills. By manipulating geographic data, students can perform in-depth spatial analysis, such as identifying distribution patterns, spatial correlations, and hotspots. This ability is very relevant in honing critical thinking skills and analyzing information systematically. The development of analytical skills in the context of utilizing geospatial technology in geography learning is something that cannot be ignored. Geospatial technologies, especially Geographic Information Systems (GIS), provide powerful tools for students to hone their analytical skills in understanding complex geographic phenomena.

By manipulating geographic data through geospatial technology, students can perform more in-depth spatial analysis. They can identify distribution patterns that may be difficult to see with the naked eye, such as human movement patterns or the distribution of flora and fauna in a region. Through this analysis, students can draw richer insights into how geographical elements interact and form certain patterns. The ability to identify spatial correlations is one of the outcomes of utilizing geospatial technology. Students can evaluate the relationship between two or more geographical variables at various locations and identify whether there is a positive, negative, or no correlation at all. This teaches them to see the broader relationships between geographic elements and understand the extent to which such interactions affect the dynamics of a region.

In addition, the ability to recognize hotspots or areas of high concentration of occurrence in spatial analysis is a valuable skill in geography. Students can identify areas that may experience significant problems or changes, such as areas with high pollution levels or areas prone to natural disasters. This provides a deeper insight into the dynamics of the region and helps students understand the impact of certain factors. The development of analytical skills gained from utilizing geospatial technology is highly relevant in honing students' critical thinking skills (Muñiz Solari, Demirci, & van der Schee, 2015a). In conducting spatial analysis, students need to systematically analyze data, identify patterns or trends that may exist, and draw conclusions based on existing evidence. This encourages students to develop the ability to think logically, objectively, and critically in processing information (Doering et al., 2014). Thus, the utilization of geospatial technology in geography learning not only enhances the understanding of geographic phenomena, but also significantly enriches the development of students' analytical skills. The ability to perform spatial analysis, identify correlations, and recognize hotspots not only has an impact on improving analytical skills, but also provides valuable provisions for students in facing complex real-world challenges (Buzo-Sánchez et al., 2022).

Active and Contextual Interaction

The use of geospatial technology allows students to actively interact with the subject matter. They can conduct independent explorations, formulate questions and test their own hypotheses based on existing data. This encourages deeper student participation and engagement, thus enriching the learning process. According to Hedden et al., (2017), the active and contextualized interaction generated by the use of geospatial technologies in learning is one of the crucial aspects that contribute to the effectiveness of geography education. These technologies provide opportunities for students to take an active role in the exploration of subject matter, creating a dynamic learning environment and focusing on whole student engagement.

With geospatial technology, students can take on the role of "explorers" or "researchers" in understanding geographic phenomena (Jamil et al., 2019). They can conduct independent exploration of digital maps, data visualizations, and other geographic information. This encourages students to develop greater curiosity and motivates them to seek deeper understanding of various geography concepts (van den Bergh et al., 2013). Students' ability to formulate questions and test hypotheses based on existing data is a direct result of active interaction with geospatial technologies. They can formulate research questions that encourage them to explore certain

concepts in depth. Furthermore, by collecting and analyzing geospatial data, students can test their own hypotheses and develop a more solid understanding of the concepts being studied (Reyes-Bueno & Loján-Córdova, 2022).

This active and contextual interaction brings a positive impact on students' engagement in the learning process. In a learning environment that allows them to think critically, formulate questions and test understanding through data exploration, students feel they have a greater role in their learning (Schultz & DeMers, 2020). This has an impact on increasing students' motivation, interest and responsibility towards their learning process. In traditional learning scenarios, students may be more passive in receiving information from the teacher. However, with geospatial technology, the role of students changes to be more proactive. They not only receive information, but also engage in data collection, analysis and interpretation. This creates a more student-centered learning environment and allows them to develop critical, analytical, and creative thinking skills. As such, the active and contextualized interactions enabled by geospatial technologies in geography learning are instrumental in creating a more immersive, relevant and powerful learning experience (Kalamas Hedden et al., 2017). Through independent exploration, question formation and hypothesis testing, students not only gain a better understanding of geography concepts, but also develop cognitive skills essential in facing real-world challenges.

Introduction to Global and Local Concepts

Geospatial technology allows students to better understand the relationship between global and local phenomena. Through mapping and analyzing geographic data, students can identify the impact of global events such as climate change or natural disasters at the local level. This helps them realize the complex interrelationship between the global scale and its impact in their region. According to Béneker & Palings, (2017), the introduction of global and local concepts in geography learning becomes richer and more relevant thanks to the utilization of geospatial technologies. These technologies, particularly Geographic Information Systems (GIS), provide students with the opportunity to better understand the complex interactions between global phenomena and their impacts at the local level (Alibrandi & Goldstein, 2015).Through mapping and analyzing geographic data, students can clearly observe how global events affect their local area (Rakuasa et al.. 2023). For example, by looking at global climate data and correlating it with local weather data, students can see how global climate change impacts the weather patterns they experience on a daily basis (Rakuasa & Latue, 2023). This helps students understand the concept of climate change in their real-life context (Vanzella Castellar et al., 2021).

The impact of other global events, such as natural disasters or global economic changes, can also be analyzed in a local context through geospatial technology (Guo et al., 2018). Students can map the locations of natural disasters, see how global economic changes affect local industries, or identify the impact of human migration due to global events. This helps students understand how events around the world have consequences that can be felt in their daily lives. With the introduction of global and local concepts through geospatial technology, students can also see how human interactions with the global environment affect local areas. For example, they can track international trade flows or global human movement patterns, and observe how these impact the

social, economic and cultural aspects of their region (Chankseliani et al., 2021). The utilization of geospatial technology in the introduction of global and local concepts provides a tangible dimension that is impossible to achieve through plain text explanations (Walshe, 2017). Students can visually see how global events interact with the region where they live, linking abstract concepts to their experienced reality. This helps students build a more holistic understanding of how the global and local worlds are interconnected in complex patterns, preparing them to become open-minded global citizens who understand the dynamics of an increasingly connected world (Béneker & Palings, 2017).

Introduction to Spatial Concepts

The integration of geospatial technologies can also help develop an understanding of spatial concepts. Students can learn about relative location, direction, distance and distribution in a more tangible context. These skills are potentially useful in everyday life, such as navigation and understanding maps. According to Jo & Hong, (2020), the introduction of spatial concepts becomes more profound and meaningful through the integration of geospatial technologies in learning. These technologies, especially Geographic Information Systems (GIS), provide students with the opportunity to understand important concepts such as relative location, direction, distance and distribution in a more tangible context and interact directly with geographic data (van der Schee et al., 2015).

In learning geography, the concept of relative location becomes easier to understand with the help of geospatial technology. Students can visually see how a location relates to other locations through interactive digital maps. This helps them understand where a place is in relation to other places, which is crucial in understanding inter-regional linkages (Walshe, 2017). The ability to understand direction and orientation can also be developed through geospatial technology. Students can manipulate digital maps to see how cardinal and compass directions apply in real contexts. This is not only relevant in geography, but also in everyday life, such as in navigation or understanding maps (Béneker & Palings, 2017). The concept of distance also becomes more concrete with the help of geospatial technology. Students can measure the distance between two locations using a distance measuring device on a digital map. This helps them understand the concept of distance visually and practically (Béneker & Palings, 2017). In addition, students can observe how distance affects relationships between places, such as the impact of distance on trade flows or human mobility.

Geographic distribution can also be better explained and understood through geospatial technology. Students can see how elements such as population, resources, or other geographic phenomena are distributed within a given region (Muñiz Solari, Demirci, & van der Schee, 2015b). This helps students understand distribution patterns and the factors that influence them. The introduction of spatial concepts through geospatial technology has practical applications in everyday life. Students not only understand the concepts theoretically, but can also relate them to real situations such as the use of maps in navigation or the understanding of urban patterns (Béneker & Palings, 2017). Thus, the integration of geospatial technology not only helps students understand geography more deeply, but also provides useful skills and understanding in various

life contexts.

Exploring Students' Research Potential

Geospatial technology provides opportunities for students to develop research projects based on geographic data. They can design research on topics that interest them, collect and analyze geographic data, and present the results visually in digital maps. According to Kerski, (2003), exploring students' research potential through the use of geospatial technology is one of the important benefits that can be obtained in learning geography. These technologies, particularly Geographic Information Systems (GIS), provide students with the opportunity to take on the role of active and creative researchers in the exploration of topics of interest to them (Muñiz Solari, Demirci, & Schee, 2015).

With geospatial technology, students can design their own research projects based on their interests and passion for geography. They can choose relevant and interesting topics, such as analysis of population movement patterns, flora and fauna distribution, local climate change impacts, or urbanization issues (Healy & Walshe, 2020). The ability to choose topics that match personal interests helps to increase student motivation and engagement in the research process. Furthermore, students can collect geographic data through various sources, such as digital maps, data from government agencies, or even field measurements. With geospatial technology, data collection becomes more efficient and accurate. For example, students can use a distance measuring device in a digital map to measure the distance between certain locations or identify coordinate points precisely (Schlemper et al., 2019). After collecting the data, students can analyze it using various geospatial analysis tools provided by the technology. They can identify distribution patterns, conduct hotspot analysis, or map spatial relationships between selected variables. The results of the analysis can be interpreted in the context of geography and used to draw insightful conclusions (Zwartjes & de Lázaro y Torres, 2019).

One of the main advantages of utilizing geospatial technology in exploring students' research potential is the ability to present research results visually in the form of interactive digital maps. Students can design maps that reflect their findings and analysis, explain distribution patterns or correlations found, and visualize the impact of certain events or factors (Kenna, 2022). As such, geospatial technologies provide a unique platform for students to develop research, analysis and problem-solving skills. Through research projects based on geographic data, students not only understand geography concepts in greater depth, but also develop critical, analytical, and creative thinking skills that are invaluable in academic development and preparation for the real world.

Challenges and Constraints

While the integration of geospatial technology offers many benefits, there are also challenges that need to be overcome. Adequate facilities, training for teachers in the use of these technologies, and equitable access for all students are needed to maximize the benefits (Kedron et al., 2021). The challenges and constraints in integrating geospatial technology in geography learning are

indeed crucial aspects that need to be understood (Metoyer & Bednarz, 2017). technology has great potential in improving the understanding of geography concepts, there are several obstacles that need to be overcome to optimize its benefits. One of the main challenges is the availability of adequate facilities. The implementation of geospatial technology requires access to hardware such as computers or tablets, as well as a stable internet connection. Unfortunately, not all schools or regions have equal access to these facilities. Inequality in technology access can lead to gaps in participation and learning between students who have access and those who do not (ANUNTİ et al., 2020).

In addition, teacher training is also a key factor in the successful integration of geospatial technology. Teachers need to have a deep understanding of how to operate GIS software, apply interactive maps in teaching, as well as facilitate spatial analysis (Jant et al., 2020). This training is not only about using the tools, but also about how to integrate these technologies with existing curriculum content. Another challenge is ensuring equitable access for all students (Béneker & Palings, 2017). The integration of geospatial technologies will only be successful if all students have equal access to devices and connectivity (van der Schee et al., 2015). Economic or infrastructure disparities in some regions may hinder the potential benefits of these technologies. Efforts are needed to ensure that access to technology is not limited to certain groups.

In addressing these challenges, collaboration between the government, schools, higher education institutions and the private sector is essential. The government can facilitate access to technology in remote areas, while higher education institutions can provide training to teachers (Gress & Tschapka, 2017). In addition, the development of more intuitive and easy-to-use devices and applications can help overcome technical barriers. In conclusion, while the integration of geospatial technology brings great benefits to geography learning, challenges such as access to facilities, teacher training, and equitable access for students need to be taken seriously. Only by addressing these challenges can the full potential of geospatial technology be realized in improving students' understanding of geography concepts and preparing them for an increasingly complex and globally connected world (Guo et al., 2018).

Teachers' Perspective on Implementation

The role of teachers in the implementation of geospatial technology is very important. Teachers need to have a deep understanding of these technologies as well as creativity in designing engaging and effective lessons (Žalėnienė & Pereira, 2021). Teachers' ability to guide students in analyzing and understanding geographic information also plays a key role. Teachers' Perspective on the Implementation of geospatial technology in geography learning is a central element that influences the success of the implementation of this technology (Turan et al., 2018). Teachers have a very important role in guiding students and creating meaningful and impactful learning experiences. In this regard, there are several aspects of the teacher's perspective that need to be considered.

Deep Understanding of Geospatial Technology: As learning facilitators, teachers should have a deep understanding of geospatial technologies, including the basic concepts of GIS, the use of software, and how to interpret geographic data (Karolčík et al., 2016). This understanding enables

teachers to recognize the potential of geospatial technology and apply it effectively in the curriculum. Creativity in Learning Design: Teachers need to develop creativity in designing engaging and relevant lessons using geospatial technologies (SAŠDIÇ & DEMİRKAYA, 2014).

They can integrate interactive maps, actual geographic data, and tasks that encourage students to perform spatial analysis (Golightly & Muniz, 2013). Creativity in the use of technology can make learning more engaging and have a deeper impact on student understanding. Facilitation of Analysis and Understanding: Teachers have a key role in guiding students in analyzing and understanding geographic information presented through geospatial technologies (Hawa et al., 2021). They can help students recognize patterns, make inferences, and relate geography concepts to real cases. These abilities help students develop critical thinking and spatial thinking skills. Adaptation to Students' Needs: Teachers need to adapt teaching by considering students' needs and learning styles (Guo et al., 2018). The integration of geospatial technology can help teachers provide a variety of learning methods that can reach different types of students. Teachers need to understand how these technologies can be used to improve student engagement and understanding.

Continuity of Professional Development: The implementation of geospatial technology requires continuous professional development for teachers (Hawa et al., 2021). Teachers must constantly update their knowledge on the latest developments in geospatial technology and the best teaching strategies (Lane & Bourke, 2019). Support from educational institutions and specialized training for teachers are essential in optimizing the use of these technologies. In conclusion, teachers' perspectives determine the effectiveness of geospatial technology integration in geography learning. Deep understanding, creativity in designing lessons, ability to guide students' analysis and understanding, and continuous professional development are key factors that ensure that these technologies are optimally used to improve students' understanding of geography concepts (TOMČÍKOVÁ, 2020).

Integrating geospatial technology in geography learning provides a number of significant benefits. The results of this study show that utilizing geospatial technology in a learning context is an innovation that has the potential to improve students' understanding of geography concepts. Here are some of the key benefits that can be identified:

1. Visualization of Abstract Concepts: The integration of geospatial technologies allows abstract geography concepts to be better explained and understood through visual representations. Geographic data can be transformed into interactive digital maps that visualize human movement patterns, population distribution, and the relationship between people and the environment. Students can relate theoretical concepts to the real world through more tangible visualizations.

2. Introduction to Global and Local Concepts: Through geospatial technology, students can observe how global events affect the local level. They can see the complex relationships between global phenomena, such as climate change or natural disasters, and their impact in their region. This helps students understand the broader interconnections between global and local scales.

3. Analytical Skill Development: The use of geospatial technology encourages the development of students' analytical skills. Through spatial analysis and manipulation of geographic data, students can identify distribution patterns, spatial correlations and hotspots. This ability hones critical thinking skills and analyzes information systematically

4. Active and Contextual Interaction: Geospatial technology allows students to actively interact with geography concepts. They can conduct independent explorations, formulate questions, and test hypotheses based on existing data. This encourages deeper student engagement and enriches the learning process.

5. Digital Skills Development: The integration of geospatial technologies helps students develop digital skills that are increasingly important in the modern world. Students learn to operate GIS software, collect and analyze data, and present results in digital formats.

6. Differentiated Learning Experience: Geospatial technology provides a different and interesting learning experience. Students not only listen to explanations from the teacher, but are also involved in mapping, data analysis and visualization creation. This increases students' enthusiasm and interest in learning geography.

7. Improved Quality of Learning: The integration of geospatial technology enables a more contextualized and applicable learning approach. Students not only understand theoretical geography concepts, but can also see how these concepts operate in the real world.

By combining these benefits, the integration of geospatial technology in geography learning creates a more powerful, interactive and motivating learning environment. Through this innovation, geography learning not only teaches theoretical concepts, but also helps students develop analytical skills, critical thinking, and a deeper understanding of human interaction with the environment.

CONCLUSION

In this study, the integration of geospatial technology in geography learning has been tested as an effective innovation in improving students' understanding of geography concepts. The results show that the use of geospatial technology allows visualization of abstract concepts, introduces global and local dimensions in a more connected manner, and stimulates the development of students' analytical skills. The use of this technology also encourages students' active interaction with learning materials, making learning more interesting and contextualized. Through a project-based approach, students engage in geographic data exploration, spatial analysis and interactive mapping. The integration of geospatial technology also helps students develop digital skills that are relevant in the modern era. However, challenges such as facility availability and teacher training remain to be overcome to ensure this integration provides maximum benefits. Thus, this study makes an important contribution to the understanding of the positive value of geospatial technology integration in geography learning. The results support the view that geospatial technology is not just an additional tool, but an innovation that can have a significant impact in improving students' learning and understanding of geography concepts.

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