Journal of Learning Improvement and Lesson Study
Volume 5 Number 1 2025, pp, 85-97
E-ISSN: 2798-9011
DOI: 10.24036/jlils.v5i1.153
Received June 12, 2025; Revised June 21, 2025; Accepted June 22, 2025
Availaible Online: https://jlils.ppj.unp.ac.id/index.php/

The Effectiveness of Using Google Earth Interactive Media on Geography Learning Outcomes

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Abstract
This study aims to examine the effectiveness of using Google Earth as an interactive medium in geography education, particularly on the topic of the location and physical features of the Earth's surface. The research was conducted using the Classroom Action Research (CAR) method in two cycles, involving 36 students from class X.E at SMA Negeri 3 Cilacap. Each cycle included learning activities that integrated exploration of Google Earth features to enhance students' spatial understanding. The results indicated a significant improvement in students' learning outcomes, with the average score increasing from 64.38 in the pre-cycle to 78.28 in Cycle I, and further rising to 87.39 in Cycle II. Additionally, the percentage of students who met the Minimum Mastery Criteria (KKM) increased from 75% to 94.44%. The use of Google Earth was proven to not only enhance spatial visualization but also to increase student engagement and learning interest. This study confirms that digital geospatial media can serve as an effective learning tool to improve students' conceptual understanding and spatial thinking skills, while also providing empirical contributions in the context of geography education in developing countries.

Keywords: geography, Google Earth, interactive media, learning outcomes, spatial learning.

Introduction

Geography education at the secondary school level continues to face significant challenges in delivering spatial content, such as the location and physical features of the Earth's surface (Koch & Tofu, 2022). The teaching of geography is often hindered by the limited availability of dynamic visualization media, making it difficult for students to deeply understand spatial concepts such as geographic location and landform structure. These topics are inherently abstract, requiring the ability to visualize in three dimensions and to grasp spatial relationships between regions. Unfortunately, in practice, many teachers still rely on conventional lecture methods and two-dimensional printed materials, such as wall maps or textbooks. As a result, the learning process becomes less interactive and lacks contextual depth, causing students to struggle in comprehending geography topics in a holistic and meaningful way (Alfatikh et al., 2020).

In today's digital era, there are various technological tools available to enhance the quality of education, one of which is Google Earth. Google Earth allows students to explore the Earth's surface in real time, presenting spatial information through maps, satellite imagery, elevation, and contour data. This tool has great potential to transform geography concepts previously confined to text into visual and exploratory experiences. Several studies have shown that the use of geospatial technologies like Google Earth can significantly increase student participation, engagement, and interest in learning geography (Chau & Dinh, 2023); (Ugli, 2025)

Nevertheless, the adoption of technologies such as Google Earth in school settings particularly within the context of Indonesia remains very limited. Teachers often lack familiarity or have not been adequately trained to effectively integrate this technology into the learning process. As a result, the vast potential of geospatial-based learning media has not been fully utilized to support student learning outcomes, especially in topics like location and landform features, which require strong spatial understanding. Therefore, it is

essential to empirically examine the effectiveness of using Google Earth as an instructional medium to enhance student learning outcomes on this topic.

Theoretically, constructivist literature and the concept of geospatial thinking support the use of interactive visual media to deepen students' spatial understanding, and recent studies have also shown that geospatial technologies promote the development of spatial thinking skills (Mašterová, 2023; Jaeger, 2024). However, the majority of research remains general in nature and does not explore the specific mechanisms by which Google Earth supports geography learning at the secondary school level. Therefore, there is a gap in the literature regarding how virtual globes can be effectively applied to focused topics such as these. Recent studies have demonstrated the positive impact of geospatial technologies on students' spatial abilities and their conceptual understanding of geography overall (Panjaitan et al., 2023).

This study specifically addresses the lack of empirical evidence regarding the focused use of Google Earth in teaching spatial topics at the secondary school level in Indonesia. By integrating theoretical foundations with classroom-based application, this research contributes to the development of digital-based geography instruction and offers insights into how virtual globes can be meaningfully integrated into pedagogical practices.

Method

This study employed a Classroom Action Research (CAR) approach. This approach was selected as it aligns with the research objective of improving instructional practices directly through the intervention of using Google Earth as a learning medium in geography (Saputra, 2021). CAR enables teachers who also act as researchers to conduct continuous evaluations of the effectiveness of the teaching and learning process in the classroom, while also actively engaging students in the improvement effort (Susilo et al., 2022; Tanjung et al., 2024).

The research was conducted at SMA Negeri 3 Cilacap, with the research subjects consisting of 36 students from Class X.E. This class was selected purposively based on the readiness of the collaborating teacher and the characteristics of the students, which aligned with the needs of the intervention. The study was carried out over two instructional cycles during the even semester of the 2024/2025 academic year, with each cycle consisting of two sessions focused on the topic of location and physical features of the Earth's surface. Google Earth was actively utilized as a visual and exploratory tool to explain geographical locations and earth surface contours in a realistic, interactive, and contextual manner.

The data collection technique employed was a learning outcomes test, aimed at measuring students' knowledge improvement before and after the intervention (pre-test and post-test) in each cycle. The test items included a combination of Lower Order Thinking Skills (LOTS) indicators such as remembering and understanding basic spatial concepts and Higher Order Thinking Skills (HOTS) indicators such as applying, analyzing, and evaluating spatial relationships using Google Earth. For example, LOTS questions assessed students' ability to identify physical features or locate geographic positions, while HOTS questions required students to interpret elevation data, compare landforms, or evaluate the suitability of specific locations based on spatial criteria.

The data collection technique employed was a learning outcomes test, aimed at measuring students' knowledge improvement before and after the intervention (pre-test and post-test) in each cycle. The data were analyzed using descriptive quantitative analysis, applying descriptive statistics to assess the average score, mastery level, and score improvement between cycles. The success criteria of the intervention were defined as an average student score of ≥ 70, with at least 80% of students achieving the Minimum Mastery Criteria (KKM) and a significant increase in scores from Cycle I to Cycle II. In addition, students' active engagement in the learning process was also considered a key indicator of the successful use of Google Earth in supporting their spatial understanding.

Results and Discussion

Based on the improvement in students' learning outcomes across two cycles of Geography instruction, it is evident that the use of interactive media such as Google Earth made a significant contribution to students' understanding, particularly on the topic of location and physical features of the Earth's surface. The application enables students to explore geographic conditions visually and contextually, which cannot be achieved through conventional teaching methods. Therefore, the following section will further discuss the

effectiveness of Google Earth as an interactive medium in Geography education, supported by a review of recent literature and empirical evidence.

Google Earth Application as Interactive Media

Google Earth provides rich geospatial visual representations, such as satellite imagery, elevation contours, and 3D features, which significantly enhance students' understanding of geographic and spatial concepts (Kurniawan et al., 2023). The use of Google Earth has been shown to increase student participation by over 75%, with average learning outcomes reaching a score of 80 out of 100 in geography-related subjects (Alfatikh et al., 2020) . Zhao et al., (2021) also reported a significant improvement in students' ability to read topographic maps after several weeks of using this application.

The use of Google Earth enables students to actively explore real-world locations and geographic phenomena, rather than merely reading theoretical explanations (Boothroyd et al., 2021). Students demonstrate a better understanding of coastal changes and geomorphological processes when using Google Earth compared to traditional teaching methods (Hsu et al., 2018; Xiang & Liu, 2017) . A study McDaniel (2022) also supports these findings, emphasizing that this application deepens students' understanding of spatial and temporal contexts through individual interaction and self-guided exploration.

The successful use of this application highly depends on instructional intervention (McLaughlin & Bailey, 2023). Jo et al., (2016) found that without proper teacher guidance, students often struggle to utilize advanced features such as elevation, contours, and storytelling. Safira et al., (2024) reinforced this aspect, stating that systematic scaffolding is essential for enabling students to effectively navigate geospatial layers.

In addition to Google Earth, interactive virtual environments based on cloud technology or virtual reality (VR) also show similar potential for geography education (Boothroyd et al., 2021). The integration of satellite imagery and remote sensing technology can enrich students' understanding of Earth phenomena through visual and collaborative learning (Montoya et al., 2023). Mercier & Rata (2017) emphasized that the development of collaborative virtual environments enhances student interaction in the process of geovisualization learning. This highlights the potential for increased effectiveness when Google Earth is combined with collaborative features and geospatial data analysis.

Here are the steps for using Google Earth Pro as a learning medium in geography education:

1. Install the Google Earth application from the Play Store or App Store, or use the web version.

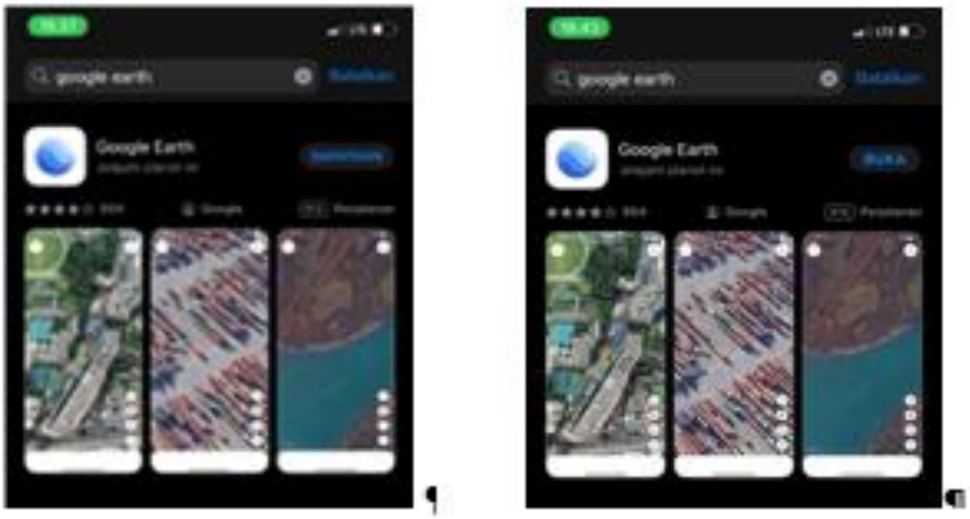

Figure 1. Application Installation Display on the App Store

If using the App Store or Play Store, type "Google Earth" in the search bar, then tap "Install" or "Get" and wait for the download to complete. Once the download is finished, tap "Open".

2. To use Google Earth on the web, type "Google Earth" into a search engine. Once the search results appear, click on the Google Earth link as shown in the image below. Then, click "Launch Google Earth."

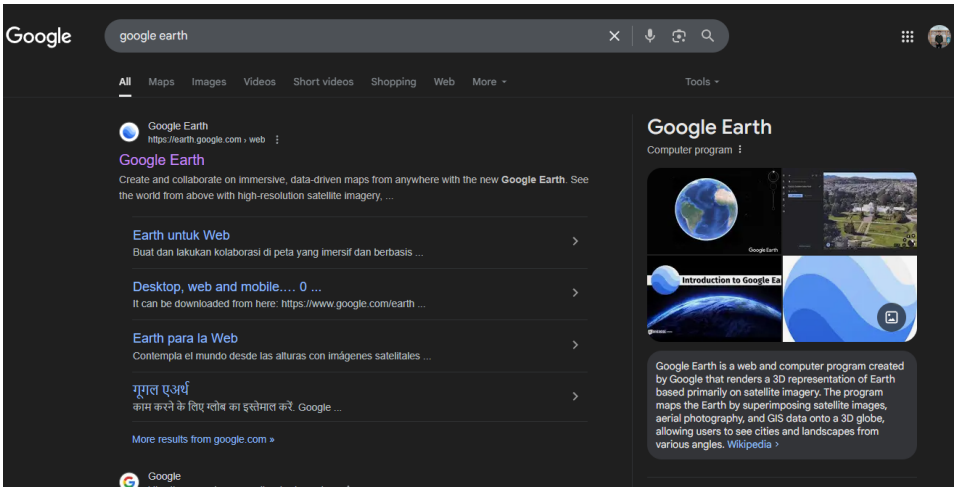

Figure 2. Initial Search for Google Earth on the Web

3. A screen like this will appear. Click "Get Started", then click "Explore Earth".

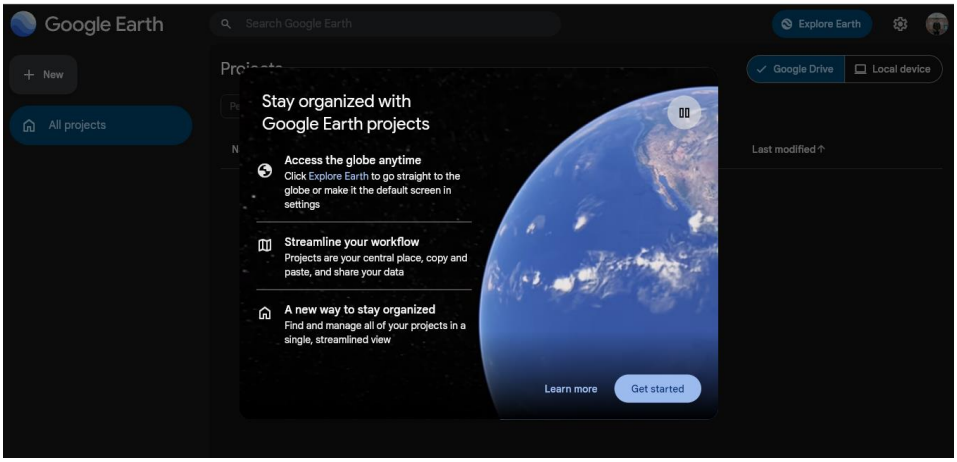

Figure 3. Initial Display of Google Earth on the Web

4. At the top section, there is a menu containing "Search Google," "Add Placemark," "Add Path or Polygon," "Measure Distance and Area," and "Activate Historical Imagery." Each menu has its own function:
   a. Search Google
      This feature is used to search for specific locations around the world using place names, addresses, or coordinates.
   b. Add Placemark
      This feature allows you to add a marker at a specific location on the map.
      Example usage: Mark the location of a house, office, or favorite tourist destination.
   c. Add Path or Polygon
      Used to draw lines (paths) or enclosed areas (polygons) on the map.
      Example usage:
      - Path → Marking a travel route.
      - Polygon → Drawing boundaries of areas such as farmland, cities, or forest zones.
   d. Measure Distance and Area
      Used to measure the distance between two points or the area of a specific region on the map.
      Example usage: Calculate the length of a road, the distance between cities, or the area of a rice field.
   e. Activate Historical Imagery
      Allows users to view satellite images from previous years at a specific location.

Example usage: Observe environmental changes over time, such as building development or deforestation.

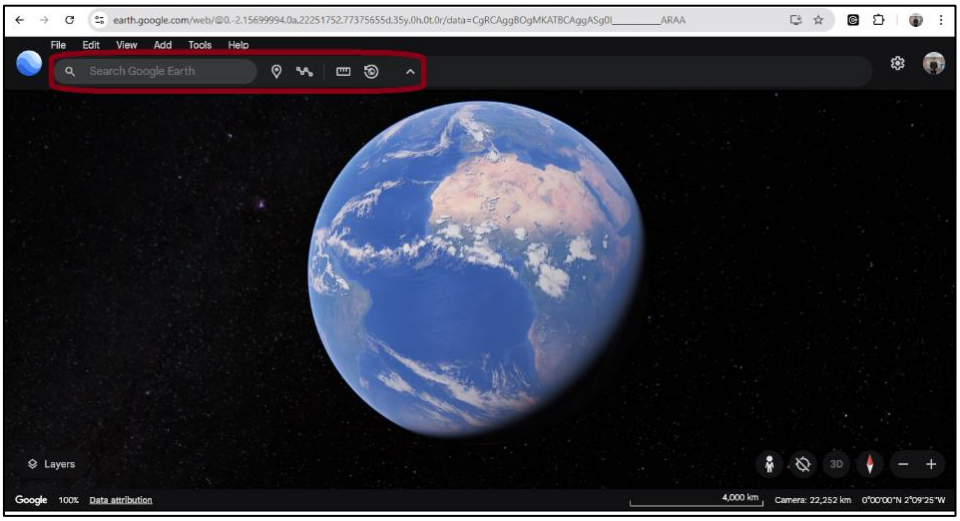

Figure 4. Menu and Features of Google Earth on the Web

5. Searching for a Place to Visit.
   When we search for a location, a display like the one above will appear. We can also view it in more detail by scrolling the mouse wheel.
6. Viewing the Historical Appearance of Natural Landscapes Over Time.
   The Activate Historical Imagery feature allows users to view natural phenomena or landscape appearances across different time periods. This tool helps students analyze environmental changes—such as deforestation, urban development, or coastal shifts—by comparing satellite images from various years at the same location.

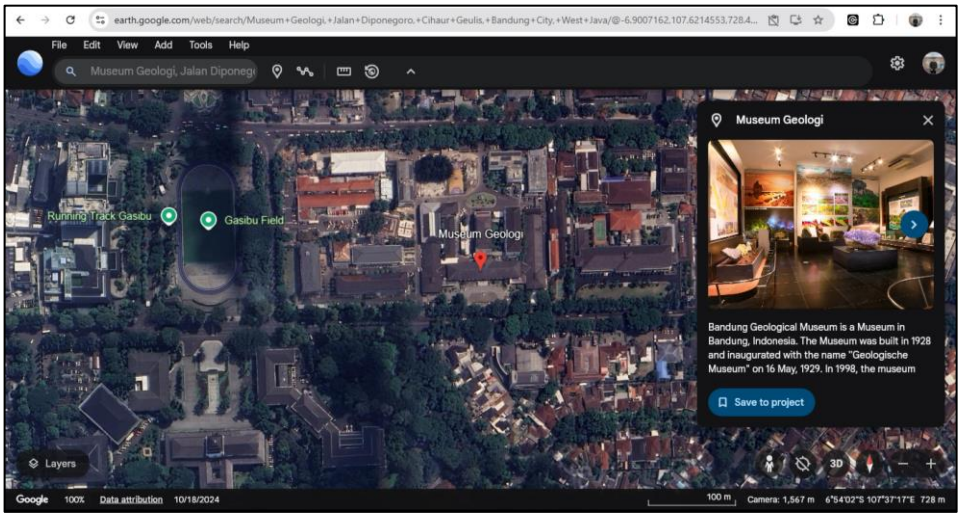

Figure 5. Searching for Locations in Google Earth

7. Viewing the Historical Appearance of Natural Landscapes Over Time. The Activate Historical Imagery feature allows users to observe natural features and phenomena across different time periods. By utilizing this tool, students can analyze changes in landscapes such as coastline shifts, urban expansion, or deforestation by comparing satellite images from various years at the same geographic location. This enhances their understanding of spatial and temporal dynamics in geography.

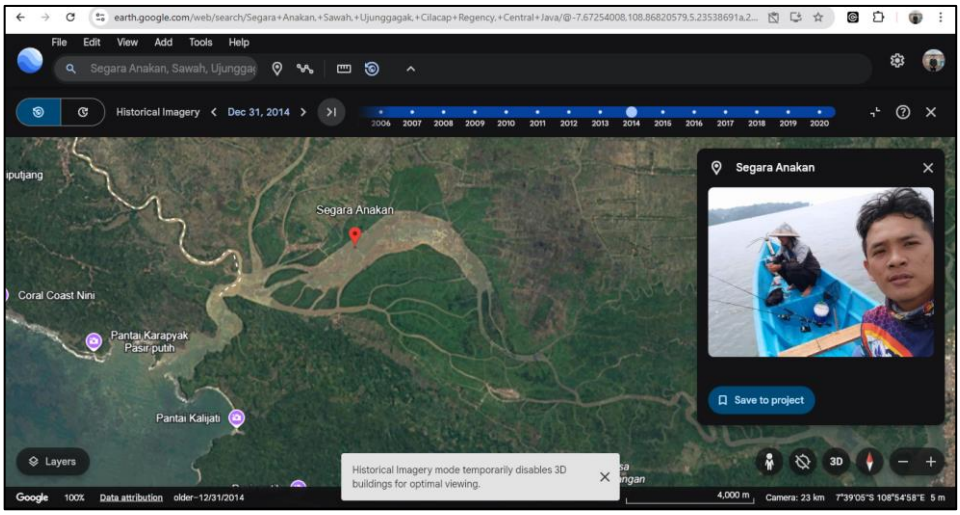

Figure 6. Viewing Phenomena Appearance Over Time

Pre-Cycle Learning Outcomes

Tabel 1. Pre-Cycle Learning Outcomes

Number	Name	Score
1	Adam saputra	48
2	Afgins nara billa	70
3	Aqila syifa putri nazihah	64
4	Aqila zulfa hamidah	66
5	Arya shandy saputra	60
6	Az-zahra aulia ashifa	72
7	Azam amarrisky	88
8	Dellia faramitha utami	80
9	Desta fatahillah putra	30
10	Dhafin azka rafiqi	54
11	Dinda asyahro	56
12	Fahar tri rachmawan	70
13	Fiorenza aurel lovely hanitya	90
14	Ibrahim chandra saputra	34
15	Kania dinda keyzia hayuningtyas	68
16	Kania pusvita nagari	60
17	Mazaya calista akmalia	84
18	Muhammad abdan syakuro	68
19	Muhammad dimas tri mahardika	40
20	Naafi'a hayyu rizkia	70
21	Nabila kholila aprillia	86
22	Naila muazara ulfa	80
23	Nanda asfhaqhun azryzhal	70
24	Natania salsabila	78
25	Navega vya aurora marayu	76
26	Nazriel arrayan vidyansa	90
27	Purry indah haqiqi	60
28	Qarel ahmad sillaby	36
29	Rangga pramudita nurfadlil	66
30	Restu wikasih afdila	56
31	Sabrina puspa rinda	86
32	Shalom monic bilkids magdhalena	30
33	Tiara amalia	32
34	Wanda alesya putri	70
35	Zain fathoni wiyoga	50
36	Zalfa nazila putri	74

Number	Name	Score
Average Score		64,38
Minimum Score		30
Maksimum Score		90

(Source: Primary Research Data)

Based on the pre-cycle data (Table 1) for the geography subject at SMA Negeri 3 Cilacap, it was observed that students' learning outcomes were still below the expected standard. The highest score recorded was only 90, while the lowest was 30, with an average score of 64.38, which remained below the Minimum Mastery Criteria (KKM). These findings indicate that the majority of students had not yet achieved the targeted competencies and reflect that the previous teaching methods were not optimal in helping students grasp abstract and spatial concepts, such as the location and physical features of the Earth's surface.

In response to this condition, the use of interactive media such as Google Earth offers a relevant alternative solution. This application allows students to digitally explore and visualize the Earth's surface in three-dimensional views, thereby bringing Geography content to life content that was previously only presented through two-dimensional images in textbooks. By integrating Google Earth into the learning process, it is expected that students' engagement and comprehension of the material will increase significantly.

Cycle I Learning Outcomes

In Cycle I, the use of Google Earth as an interactive learning medium began to show a positive impact on students' learning outcomes in Geography, particularly on the topic of location and physical features of the Earth's surface. This was evident from the increase in the average student score from 64.38 in the pre-cycle to 70.52 after the implementation of the learning media. In addition, the number of students who met the Minimum Mastery Criteria (KKM) rose from 29 students (75%) to 34 students (94.44%). Nevertheless, there were still 4 students (5.55%) who did not meet the KKM, indicating that the use of this interactive media needs further refinement both technically and in terms of its integration into the learning activities.

The learning process using Google Earth enabled students to explore real-world earth surface conditions visually and in three dimensions. With features such as satellite imagery, topographic views, and geographic location navigation, students were able to understand spatial relationships between regions in a more contextual manner. Learning activities involving digital exploration also encouraged active student engagement, fostered curiosity, and enhanced comprehension of geographic concepts that were previously considered abstract. These findings demonstrate that Google Earth is not only a visual aid but also an effective interactive learning medium for improving student learning outcomes and spatial thinking skills.

Table 2. Pre-Cycle I Learning Outcomes

Number	Name	Score
1	Adam saputra	60
2	Afgins nara billa	88
3	Aqila syifa putri nazihah	80
4	Aqila zulfa hamidah	82
5	Arya shandy saputra	66
6	Az-zahra aulia ashifa	84
7	Azam amarrisky	90
8	Dellia faramitha utami	88
9	Desta fatahillah putra	56
10	Dhafin azka rafiqi	70
11	Dinda asyahro	66
12	Fahar tri rachmawan	80
13	Fiorenza aurel lovely hanitya	96
14	Ibrahim chandra saputra	68
15	Kania dinda keyzia hayuningtyas	80
16	Kania pusvita nagari	74
17	Mazaya calista akmalia	90
18	Muhammad abdan syakuro	86
19	Muhammad dimas tri mahardika	70

Number	Name	Score
20	Naafi'a hayyu rizkia	80
21	Nabila kholila aprillia	96
22	Naila muazara ulfa	86
23	Nanda asfhaqhun azryzhal	76
24	Natania salsabila	90
25	Navega vya aurora marayu	82
26	Nazriel arrayan vidyansa	96
27	Purry indah haqiqi	80
28	Qarel ahmad sillaby	66
29	Rangga pramudita nurfadlil	80
30	Restu wikasih afdila	70
31	Sabrina puspa rinda	90
32	Shalom monic bilkids magdhalena	64
33	Tiara amalia	62
34	Wanda alesya putri	80
35	Zain fathoni wiyoga	60
36	Zalfa nazila putri	86
Average Score		78.27778
Minimum Score		56
Maksimum Score		96

(Source: Primary Research Data)

Based on the Post-Test results from Cycle I of Geography instruction involving 36 students, the average score reached 78.28, with the highest score being 96 and the lowest 56. This represents a significant improvement compared to the pre-cycle average score of 64.38. This increase reflects the positive impact of implementing interactive media Google Earth on students' understanding of the topic "location and physical features of the Earth's surface."

Data analysis showed that the majority of students exceeded the Minimum Mastery Criteria (KKM), with many scoring above 70. The highest achiever, scoring 96, demonstrates that Google Earth not only helps students grasp basic concepts, but also supports them in achieving a higher and more applied level of conceptual mastery. Although a few students still scored below 70 (e.g., 56 and 60), the overall data trend clearly indicates improvement, especially when compared to lower scores in the pre-cycle phase.

This improvement in learning outcomes is strongly linked to the visual and spatial advantages offered by Google Earth. Through interactive digital exploration of the Earth's surface, students are not only learning theoretical concepts but also directly observing and navigating physical features via satellite imagery and 3D maps. This creates a more contextualized, concrete, and engaging learning experience for students throughout the lesson.

Furthermore, the score improvements of students who previously performed poorly now surpassing the KKM indicate that interactive media like Google Earth is effective in reducing individual learning gaps. This suggests that Google Earth benefits not only high-achieving students, but also those who initially struggle with spatial concepts.

In summary, the findings affirm that technology-based geospatial interactive media such as Google Earth can enhance students' conceptual understanding in Geography, provide a more enjoyable and meaningful learning experience, and promote more equitable and effective achievement of learning objectives.

Pre-Cycle II Learning Outcomes

Based on the Post-Test results of Cycle II involving 36 students in Geography learning on the topic of location and physical features of the Earth's surface, the average score reached 87.39, with the highest score being 100 and the lowest 66. When compared to the Cycle I Post-Test average of 78.28, this reflects a significant improvement of 9.11%. This indicates a continued increase in learning effectiveness, particularly after the optimized use of the interactive media Google Earth in the instructional process.

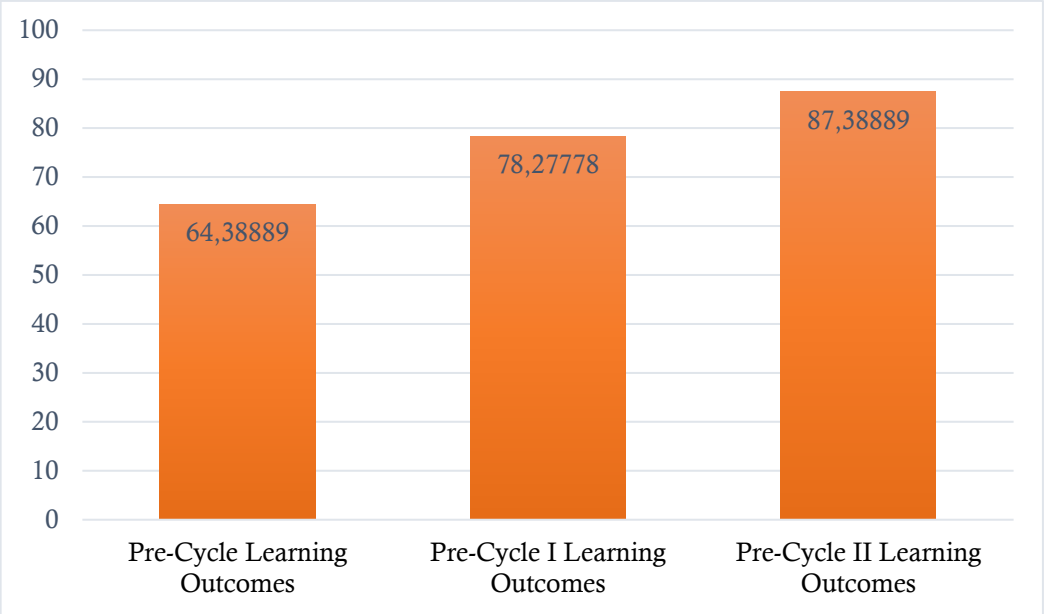

Figure 7. Recapitulation of Average Learning Outcomes

In addition, a recap of improvements in learning outcomes can be seen in the following table.

Table 4. Pre-Cycle II Learning Outcomes

Number	Name	Score
1	Adam saputra	80
2	Afgins nara billa	90
3	Aqila syifa putri nazihah	84
4	Aqila zulfa hamidah	84
5	Arya shandy saputra	78
6	Az-zahra aulia ashifa	88
7	Azam amarrisky	96
8	Dellia faramitha utami	98
9	Desta fatahillah putra	66
10	Dhafin azka rafiqi	86
11	Dinda asyahro	84
12	Fahar tri rachmawan	90
13	Fiorenza aurel lovely hanitya	100
14	Ibrahim chandra saputra	68
15	Kania dinda keyzia hayuningtyas	80
16	Kania pusvita nagari	90
17	Mazaya calista akmalia	100
18	Muhammad abdan syakuro	90
19	Muhammad dimas tri mahardika	88
20	Naafi'a hayyu rizkia	88
21	Nabila kholila aprillia	100
22	Naila muazara ulfa	90
23	Nanda asfhaqhun azryzhal	80
24	Natania salsabila	98

Number	Name	Score
25	Navega vya aurora marayu	98
26	Nazriel arrayan vidyansa	100
27	Purry indah haqiqi	88
28	Qarel ahmad sillaby	76
29	Rangga pramudita nurfadlil	88
30	Restu wikasih afdila	88
31	Sabrina puspa rinda	98
32	Shalom monic bilkids magdhalena	80
33	Tiara amalia	74
34	Wanda alesya putri	80
35	Zain fathoni wiyoga	86
36	Zalfa nazila putri	94
Average Score		87.38889
Minimum Score		66
Maksimum Score		100

(Source: Primary Research Data)

This improvement in scores indicates that the majority of students not only succeeded in surpassing the Minimum Mastery Criteria (KKM), but also demonstrated a deeper and more conceptual understanding of the material. A total of six students achieved a perfect score of 100, and more than 80% of students scored above 85, highlighting the success of using Google Earth in helping students comprehend spatial aspects both visually and contextually. Compared to the pre-cycle and Cycle I, the score distribution in Cycle II was significantly more even, with fewer students achieving low scores. This reflects the refinement of teaching strategies and the increased effectiveness of the media used.

Through Google Earth's features including satellite imagery, topographic models, location navigation, and three-dimensional views students were able to directly explore the Earth's surface, making previously abstract geographical concepts more concrete and applicable. The learning process also became more engaging, as students interacted directly with digital maps that closely resemble real world conditions. This not only improved learning outcomes but also encouraged active engagement and curiosity among students throughout the learning process.

Discussion

The results of the classroom action research (CAR) indicate that the use of Google Earth significantly improves students' learning outcomes in the topic of Earth's location and surface features. The average post-test scores increased from 78.27 in Cycle I to 87.38 in Cycle II, with the percentage of students meeting the minimum mastery criteria (≥ 70) rising from 75% to 94.44%. These findings are consistent with the study by Alfatikh et al. (2020 which reported an average score of around 80 and student engagement above 75% when using the same media. In addition, several other studies also affirm that the use of Google Earth in classroom learning enhances both academic achievement and students' conceptual understanding (Mandalika, 2025; Hakim, 2024; Yusuf et al, 2024).

In addition to cognitive aspects, observations and interviews revealed a significant improvement in students' spatial thinking skills. This aligns with several studies that found the use of Google Earth had a positive impact on spatial reasoning among high school students (Vanti et al., 2024). For example Xiang & Liu (2017) found that students who used Google Earth demonstrated a better understanding of coastal changes and geomorphological features compared to those who learned through traditional textual methods. Hsu et al. (2021) also reported improvements in topographic map reading skills after a three-week intervention. However, the successful implementation of Google Earth is not automatically achieved without proper teacher facilitation and training (Zhang et al., 2025). Students who are not adequately guided tend to face difficulties in operating the application's advanced features (Aini & Suasti, 2025). Similar findings have emerged from other research, emphasizing that pedagogical scaffolding and direct supervision are essential to optimizing the benefits of Google Earth for learners (Widodo et al., 2025).

This study is also consistent with the findings of a systematic review by Schmidt & Stumpe (2025) which emphasized that the use of geospatial tools such as Google Earth significantly contributes to the enhancement of students' spatial thinking skills. However, the novelty of this research lies in its application within the context of Classroom Action Research (CAR) in Indonesia, focusing specifically on the topic of earth's location and surface features, which has not yet been examined through quasi-experimental approaches. The use of Google Earth significantly improves students' spatial perception abilities, as confirmed by statistical data. Similarly, other studies have shown a notable improvement in geospatial learning processes (Aliman et al., 2024). From a broader perspective on the need for spatial knowledge, exercises involving geospatial maps have been found to enhance students' ability to locate objects and understand spatial relationships, which are fundamental components of geographic competence (Jaeger, 2024). These findings reinforce that Google Earth is an effective tool for sharpening such aspects of spatial thinking.

Overall, this study not only confirms previous findings on the effectiveness of geospatial media but also presents empirical evidence through Classroom Action Research (CAR), examining the tangible impact on student learning outcomes. It also includes a qualitative analysis of teacher and student perceptions, and provides a new contextual contribution to the literature on geospatial education in developing countries.

Conclusion

Based on the findings from two cycles of instruction, it can be concluded that the use of Google Earth as an interactive learning medium has proven to be effective in improving student learning outcomes in Geography, particularly in the topic of location and physical features of the Earth's surface. The increase in students' average scores from 64.38 in the pre-cycle to 87.39 in Cycle II indicates a significant enhancement in conceptual understanding and spatial thinking skills. Moreover, student engagement and enthusiasm also improved along with the visual and interactive exploration facilitated by Google Earth. This medium successfully bridges abstract geographical concepts into more concrete and comprehensible forms for students.

These findings have important implications for teachers and education practitioners, particularly in the integration of geospatial technology as part of instructional innovation. Google Earth can serve as an effective alternative medium for teaching geography content that requires high levels of spatial visualization and understanding. Therefore, it is essential to enhance digital media training for teachers, and for the geography curriculum to become more receptive to the integration of digital map-based technologies, enriching students' learning experiences in the digital age.

However, this study is not without limitations. The research was conducted in a limited sample and school context, which may affect the generalizability of the findings. In addition, the study focused primarily on cognitive learning outcomes and did not explore in depth other aspects such as long-term retention or the impact on students with different learning styles. Future research is recommended to include a broader range of schools, investigate long-term effects, and explore how Google Earth can be adapted to different topics within geography education as well as its impact on diverse learner profiles.

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