Analyzing the Needs for Augmented Reality-Based Learning Media in Geography Education: A Case Study of Landform Material

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Abstract. Learning media in Geography learning, landform material is an important element to increase students' understanding. Not all types of learning media are suitable as learning media for landform material. The purpose of this research is as an initial study to collect information in the context of needs analysis to design a draft for the development of adequate landform material learning media. The research was conducted using a combined method with a sequential exploratory strategy. The research objects for needs analysis are Geography teachers and students of class XI IPS SMA N 8 Malang City. The research results showed that students at SMAN 8 Malang City found it difficult to understand landform material using existing learning media and felt bored during landform learning. The results of the needs analysis show that augmented reality as a learning medium for landform material is the most popular, namely 37.2%. Therefore, a design was carried out to develop learning media called Spark AR-3D Maps which integrates augmented reality with geospatial technology.

Keywords: Learning Media, Landform, Augmented Reality.

1   Introduction

21st century learning has a different learning orientation influenced by the rapid development of science and technology (IPTEK). 21st century learning invites students to learn through application and experience in the real world (Massari et al., 2021; Stanley, 2021). Students in the 21st century are required to be able to integrate knowledge, skills, attitudes and mastery of science and technology (R. Wulandari, 2021). The demands of 21st century learning will become the basic provisions for meeting global demands, life and the world of work.

Learning media in the 21st century is experiencing development from conventional media to digital media (Rahayuningsih & Muhtar, 2022). Digital learning media has an important role in helping students to better understand learning material (Miftah, 2013). Learning media makes it easier for teachers to convey complex material and makes it easier for students to understand it. Learning media is classified into six,

namely: text, video, visual, audio, engineer (*manipulative*), and human (Samaldino et al., 2014). Manipulative learning media is one of the digital media that is experiencing rapid development. Examples of developing manipulative learning media are *Augmented Reality* (AR), *Virtual Reality* (VR), and *Mixed Reality* (MR) (Al Farsi et al., 2021; Fotouhi-Ghazvini et al., 2011; Hakiki et al., 2022).

Learning media is an essential part of G eography learning. Physical geography study objects cannot be presented in classroom learning. To explain this, the teacher only presents pictures in the book so that students can only see the object of study. Meanwhile, *field trips* or *outdoor learning* activities have big risks related to security and require more expensive costs (Lee et al., 2020). Therefore, learning media in Geography learning has an important role to help teachers present Geography study objects in the classroom.

Landform material is basic material in geography which discusses the shape of the earth's surface and the impacts it causes (Lin et al., 2022; Xu et al., 2022). Landform material includes ten genesis starting from volcanic, structural, fluvial, solutional, denudational, aeolin, marine, glacial, organic, and anthropogenic (Van Dam, 2012). Landforms relate to certain geomorphic features on the earth's surface that have different characteristics, and are widely recognized as natural objects that divide the earth's surface into essential spatial entities (Mokarram & Sathyamoorthy, 2018). Because it is closely related to the description and spatiality of the earth's surface, landform material in geography subjects should be presented with spatial visuals (Bostjančić et al., 2023).

Previous research results show that the use of dynamic and interactive learning media can help improve students' understanding of landform material (Silalahi et al., 2018). Similar findings show that the use of three-dimensional (3D) models in learning landform material can improve students' conceptual understanding and ability to identify various landforms (Planar & Moya, 2016). The results of other research state that learning media for landform material must be able to provide a realistic visual experience so that it can increase students' interest and motivation in landform learning (Yannier et al., 2008). However, in practice, landform material learning media is not given much attention. Given the challenges posed by the complex nature of landform materials, there is an urgent need for appropriate and effective learning media that can convey this complex information efficiently without oversimplification. This research serves as an initial exploration, focusing on the important task of gathering information through a comprehensive needs analysis. The main objective is to pave the way for the creation of new and well-adapted learning resources for landform material.

In the educational research landscape, the novelty of this research lies in its dedication to addressing specific challenges associated with the study of landform material. It aims to bridge the existing gap in adequate educational resources for this topic. By conducting a careful needs analysis, we aim to identify the unique needs and preferences of students and teachers in the context of landform education. This tailored approach ensures that future learning media will be relevant and innovative, thereby contributing to a more effective and engaging learning experience.

2   Research methods

2.1   Research Design and Subjects

This research uses a mixed methods approach with a *sequential exploratory strategy* (crestwell, John W.; Creswell, 2018). The *exploratory sequential* strategy is a strategy for determining the order of data collection. *Exploratory sequential* collects qualitative data first and then becomes the basis for collecting quantitative data (Åkerblad et al., 2021; McKim, 2017).

The objects of this research were 2 Geography teachers at SMA N 8 Malang City and students in class XI IPS at SMA N 8 Malang City. The number of students involved was 43 who were selected using a *simple random sumpling technique.* The type of data collected is qualitative and quantitative data using data collection techniques such as interviews, observations and questionnaires. Data analysis was carried out using Miles and Huberman analysis techniques (Sugiyono, 2019)and descriptive statistics (Azmi, 2018; Darmawan, 2019).

2.2   Data Collection Instrument

The data collection instruments used in this research were observation, interviews and questionnaires. Observations are carried out to observe the learning process in class. The types of observations carried out are frank and covert observations (Sugiyono, 2019). Interviews were conducted with 2 Geography teachers at SMAN 8 Malang City who knew in detail the process of learning landform material in the classroom. The purpose of conducting observations and interviews is to find out obstacles during the learning process. The type of interview chosen to collect data was a semi-structured interview in accordance with the aim of finding problems openly and sources were asked for their opinions and ideas (Sugiyono, 2019). The questionnaire is used to find out students' opinions regarding the learning media that have been used by teachers in the learning process and to find out the learning media desired by students using a Likert scale. There are two indicators used in this learning media analysis, namely understanding and learning motivation.

2.3   Data Analysis

2.3.1   Qualitative Data

Data from observations and interviews were analyzed using the Miles and Huberman model analysis technique. The Miles and Huberman data analysis technique was chosen because it is flexible but capable of investigating in depth, this is because during data collection the researcher immediately carried out an analysis of the interviewee's answers (Sugiyono, 2019). The steps in Miles and Huberman's data analysis are collection, reduction, display, and verification.

2.3.2   Quantitative Data

Quantitative data obtained from distributing learning media analysis questionnaires. The collected data was analyzed using descriptive statistical analysis by presenting the data through tables and calculating percentages. The following is the formula used to calculate percentages as a reference for processing data from learning media analysis according to Windawati & Koeswanti, (2021) :

Formula for calculating the percentage of data per indicator item:

$$P = \frac{x}{\mathrm{xi}} \cdot 100\%$$

Information:

P = Percentage

X = Respondent's score

X_i = Ideal score (Number of Indicators × Highest score)

3   Results and Discussion

3.1   Geography Teacher Obstacles in the Landform Material Geography Learning Process

The interview results show that Geography teachers need more time allocation in delivering landform material compared to other Geography material. Landform material includes ten genesis starting from volcanic, structural, fluvial, solutional, denudational, aeolin, marine, glacial, organic, and anthropogenic (Van Dam, 2012). Followed by an explanation regarding the formation process and the impacts resulting from the process of landform genesis (Bachri et al., 2023; Blaszczynski, 1997). The complexity of the landform material is a factor in requiring more time allocation compared to other materials. Apart from that, choosing a learning strategy is a solution to make learning more efficient and effective in solving landform material complexity problems.

Observation results revealed that teachers at SMAN 8 Malang City did not use spatial visuals in explaining landform material. They only rely on PowerPoint slides and printed teaching materials. This is a concern because landform materials are naturally closely related to spatial concepts. The choice of PowerPoint slide learning media is based on the Geography teacher's ability to develop this media. These findings indicate that there is potential to improve teaching methods and the use of media in

delivering landform material. The integration of spatial visuals such as maps or visualization technology can increase students' understanding of landform concepts and their relevance to spatial dimensions.

Learning media that can combine visual and spatial elements is an effective alternative in solving problems in learning landform material at SMAN 8 Malang City. The results of the next interview are the formulation of learning media which is the starting point for development, namely animated video learning media, maps, augmented reality and virtual reality.

3.2   Students' Opinions on the Learning Media Used by Teachers in Landform Material

The indicators used in learning media analysis are assessment of learning media in terms of understanding of the material and motivation to learn (Arthur et al., 2019). The learning media analyzed are power point slides and learning videos that teachers use to help deliver landform material. Power point slides developed by the Geography teacher at SMAN 8 Malang City contain explanations in the form of text and supporting landform images. Meanwhile, learning videos are not developed in-house but are taken from online platforms. This is because Geography teachers do not have the skills to develop learning video learning media.

The results of the analysis of learning media on material understanding indicators show that students have difficulty understanding landform material using existing learning media. Indicators of understanding landforms include the ability to identify and explain landforms, compare and contrast various landforms, describe geological processes with landform formation, describe human interactions with landforms, apply landform concepts in real contexts, and analyze and solve problems related to landforms (Hurni, 2010 (Hurni, 2010).

Based on the data obtained from the results of the questionnaire analysis, it can be seen that the largest percentage, namely 44.96%, felt that it was quite difficult and only 6.98% of students felt that it was easy to understand the landform material using the learning media of PowerPoint slides and learning videos. Meanwhile, there were no students who felt that it was very easy with power point slides and learning videos for landform material.

Table 1. Results of Learning Media Analysis of Understanding Indicators

Indicator	Very Difficult	Enough Difficulty	Difficulty	Made easy	Very Easy
Understanding	12.40 %	44.96 %	35.66 %	6.98 %	0 %

The results of the analysis of learning media on the learning motivation indicator show results that are not much different from the indicator of understanding the material. Most students feel that the learning media used does not motivate them. The percentage of students' assessments of the landform learning media that has been used at SMAN 8 Malang City shows that 43.41% of students assess that the learning media is very

unmotivating, 44.19% of students assess that it is not motivating, and the remainder give a neutral assessment.

Table 2. Results of Learning Media Analysis of Learning Motivation Indicators

Indicator	Very Unmotivating	Not Motivating	Neutral	Motivating	Very Unmotivating
Motivation	43.41 %	44.19 %	12.40 %	0 %	0 %

The understanding and motivation data shows that the landform learning media at SMAN 8 Malang City is not able to make it easier for students to understand the material and motivate students to learn. This indicates that the media is not effective in conveying information so that it is easy for students to understand (Wahyuni, 2018). Apart from that, landform learning media has not been able to fulfill its role as a medium that aims to motivate students to be enthusiastic and enthusiastic in learning (A. P. Wulandari et al., 2023).

The results of the learning media analysis show that there is a need to update learning media at SMAN 8 Malang City. Next, student analysis is carried out to get students' opinions regarding the learning media that will be created. From the results of the question regarding whether it is necessary to develop learning media, 93% of students chose it is necessary and 7% chose it is not necessary. This result is directly proportional to the results of the learning media analysis which concluded that it was necessary to develop new learning media that could help students understand landform concepts and motivate students to learn.

3.3   Learning Media Desired by Students

Based on the results of the formulation of learning media together with the Geography teacher, a questionnaire was created for students to choose from. The role of students in determining the desired learning media provides diverse points of view. This creates an important collaborative framework in the development of learning media.

The learning media choices are animated videos, maps, augmented reality (AR), and virtual reality (VR). The results of the analysis of appropriate learning media to be developed can be seen in Table 3.

Table 3. Analysis of Appropriate Learning Media to Develop

Instructional Media	Frequency	Percentage
Animation Videos	14	32.6 %
Map	4	9.3 %
Augmented Reality	16	37.2 %
Virtual Reality	9	20.9 %

Based on this analysis, augmented reality is the learning media of choice to be developed on landform material with a percentage of 37.2%.

Augmented reality has three characteristics, namely: 1) Interactive because it creates interaction between the user's real world and the virtual world; 2) Provide real

time (real time); 3) Presented in 3D space (Huang, 2016; Wegha et al., 2021). AR is able to provide direct visual displays in 3D space, thereby providing an interesting experience for its users (Palaigeorgiou et al., 2018). From these characteristics and supported by the results of the needs analysis, augmented reality (AR) is suitable for development as a learning media on landform materials.

3.4   Spark AR-3D Maps Learning Media Design

Augmented Reality (AR) which is integrated with maps as a learning medium for landform material is suitable for development because it can present complex information in a concise form and give a real impression of the visual map in displaying landforms. This can be seen from the characteristics of AR media which combines the real world with the virtual world and provides a picture of the same place (Haryani & Triyono, 2017). So, it can be used in Geography learning to bring material study objects into the classroom virtually via *smartphone* (Palaigeorgiou et al., 2018).

Spark AR-3D Maps is the branding or name of the learning media that will be developed. The concept of using Spark AR-3D Maps is almost the same as marker-based augmented reality in general, namely by scanning available markers using a smartphone. However, Spark AR-3D Maps has many advantages because it integrates augmented reality with geospatial technology. Geospatial technology is implemented in the form of a 3D map, which will later become a marker for augmented reality.

The specifications for the Spark AR-3D Maps learning media for the subject of landform are as follows: 1) Physical form in the form of a 3D landform map printed on A2 paper (42 CM × 54 CM) equipped with the main components of the map; 2) The 3D map functions as a marker that will display AR landform visualization; 3) When a 3D map is scanned, not only a visualization of the landform appears but it is also equipped with audio explaining the details of the landform; 4) The area used as a learning object is Java Island; 5) There are 7 landform genesis out of 9 genesis discussed in the Spark AR-3D Maps media, namely volcanic, structural, fluvial, solutional, denudational, aeolin, and marine.

The following is an object of discussion of landscape material according to Genesis which was developed into augmented reality on Spark AR-3D Maps:

Table 4. Plotting the Location of Landform Genesis Objects on the Island of Java

No	Genesis Landform	Augmented Reality Objects
1	Volcanic	Mount Semeru in Bromo Tengger Semeru National Park
2	Structural	Ciletuh Fold and Lembang Fault in West Java
3	Fluvial	Brantas River
4	Solutional	Pindul Cave in Gunungkidul Special Region of Yogyakarta
5	Denudational	Dieng Plateau in Central Java
6	Aeolin	Boko Hill in Yogyakarta

| 7 | Marine | Pangandaran Beach in West Java |

The selection of development location objects is based on several scientific considerations. Mount Semeru is used for volcanic genesis studies because it is the highest mountain on the island of Java and one of the most active mountains in Indonesia (Priyambodo et al., 2022). So that learning media can include information about Mount Semeru regarding types of volcanic eruptions, eruption cycles, and their impact on the surrounding environment (Wahyudin, 2010).

The Ciletuh Fold and Lembang Fault in West Java are used as structural genesis studies because this region has a diversity of geology and tectonic structures (Martodjojo, 1984). Apart from that, this region is an area with significant tectonic activity (Pamungkas et al., 2018). So, in learning media, students can understand the process of deformation of the earth's crust which causes the formation of structural landforms.

The Brantas River is the longest river on the island of Java with a length of 320 km across various types of landforms (Fahmi & Abtokhi, 2020). This is an advantage if the Brantas River becomes an object of study in learning media because it can provide examples regarding the role of rivers in forming land such as valleys, terraces, deltas and flood plains. In addition, long rivers offer the opportunity to study various fluvial aspects including flow patterns, meanders, and sedimentation (Raharjo et al., 2017).

Pindul Cave is an appropriate object as a learning medium for solutional landform genesis because Pindul Cave was formed through the process of dissolving limestone by rainwater containing carbonic acid (Suryana & Wijayanti, 2020). Apart from that, a series of stalactites and stalagmites are an interesting solutional phenomenon that can be discussed in learning media. Thus, Pindul Cave can be an object in explaining limestone rocks, dissolution and deposition processes, as well as karst landforms.

The Dieng Plateau is a good example of a denudational landform because it has various interesting landforms such as valleys, crevasses, ridges and eroded plateaus (Dwi Widiyaningsih, 2020). The diversity of land forms in the Dieng Plateau was formed through natural erosion by weather, water and wind factors (Haryono et al., 2012). So, the learning media can explain how the erosion process affects the appearance of the land.

Boko Hill is suitable as a study object for learning media about aeolin genesis because the sand dunes clearly show the role of wind. Boko Hill as a learning media object can provide understanding regarding the process of material sedimentation by wind. This process includes the formation, transportation and deposition of sand produced by the wind (Akhbar et al., 2020).

Pangandaran Beach has varied beach characteristics such as curved coastlines, coral cliffs and extensive sand beaches (Sopandi et al., 2020). If used as a learning medium, these diverse coastal characteristics will help students understand the various physical features of marine landforms. Apart from that, Pangandaran Beach can explain the influence of waves and sea currents on landform changes, sediment deposition and beach formation processes.

Based on this data, augmented reality was then developed using Blender 3.4 software. The following is an augmented reality draft of Mount Semeru
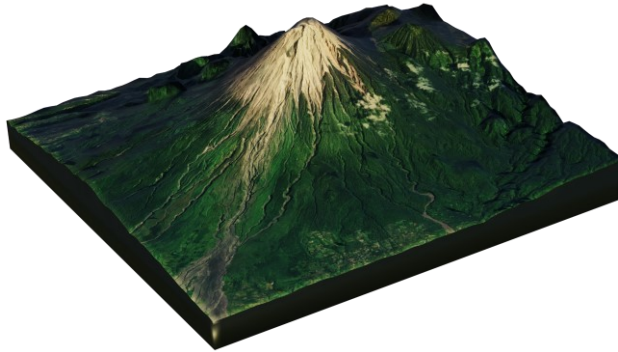
Fig 1. Object Augmented Reality Mount Semeru

The augmented reality landform visualization will display detailed descriptions of each part as well as audio explanations that also appear when the augmented reality is scanned. Spark AR-3D Maps learning media has the potential to be more popular with students because its use utilizes smartphone digital media. In addition, Spark AR-3D Maps can enrich the learning experience and increase learning efficiency because it shortens the description of complex landform material.

4   Conclusion

The results of the research show that students at SMAN 8 Malang City have difficulty understanding landform material using power point slide learning media and learning videos. Students at SMAN 8 Malang City also think that the learning media used by teachers is not successful in motivating them so they often feel bored during landform learning. The results of the needs analysis show that augmented reality is the most popular learning media for landform material, namely 37.2% compared to other visual learning media. The augmented reality media developed is called Spark AR-3D Maps. Spark AR-3D Maps learning media specifications for landform material are: 1) Physical form in the form of a 3D landform map printed on A2 paper (42 CM × 54 CM) equipped with the main components of the map; 2) The 3D map functions as a marker that will display AR landform visualization; 3) When a 3D map is scanned, not only a visualization of the landform appears but it is also equipped with audio explaining the details of the landform; 4) The area used as a learning object is Java Island; 5) There are 7 landform genesis out of 9 genesis discussed in the Spark AR-3D Maps media, namely volcanic, structural, fluvial, solutional, denudational, aeolin, and marine. The findings in this research can be used as a basis for further research to develop learning media on landform materials. It would be better for future researchers to add more comprehensive indicators when conducting needs analysis.

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