Forming spatial thinking skills of social studies students in phenomenon analysis geosphere through the Geographic Information System (GIS)

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Abstract. Spatial thinking skills are characteristic and an important part of learning geography. Geography studies in which various analyzes geosphere is phenomena can be solved by spatial thinking. Resolve geosphere phenomena, for example, disaster vulnerability can be assessed using assistance from Geographic Information Systems (GIS). Article writing procedure was carried out by examining, comparing, and interpreting the results of similar studies that have been explained in the form of journals and articles. Data analysis was performed using qualitative descriptive analysis techniques. Based on the analysis results it is described that the Geographic Information System (GIS) provided an important role in creating and improve skills students’ spatial thinking. GIS provides opportunities for social studies students to explore the geosphere phenomenon in the surrounding environment uses technology. Increased spatial thinking skills make students better recognize the condition of the surrounding environment from various aspects of both threats, vulnerability, and risk of disaster.

1. Introduction
Geography is the study of various geosphere phenomena on the earth's surface that is studied through 3 approaches, namely: spatial, ecological, and territorial. Geographical studies of space discuss the similarities and differences of geosphere phenomena from an environmental or territorial point of view in spatial contexts [11]. Setiawan [15] explains that the study of geographical phenomena not only explains a phenomenon and its process but also studies the shape, size, direction, pattern of a phenomenon, and its relationship with other phenomena. So that in studying Geography, it requires more complex spatial thinking skills.

Spatial thinking ability is a basic cognitive skill for spatial thinking which consists of spatial visualization, spatial orientation, and spatial relationships [17]. Spatial visualization is the mental ability to manipulate, rotate, or reverse visual stimulation that is displayed pictorially. Spatial orientation is an understanding of the arrangement of patterns of elements produced by visual stimuli, the intelligence to stay calm in the face of all changes in orientation, and the ability to decide spatial relationships. Whereas spatial is the ability to see the visual world spatial visual accurately and visualize changes in perception. These three elements, when combined, will produce spatial thinking skills. In geography learning, activities to make it easier to study geosphere phenomena can be assisted by the use of proper learning media.

Learning media is a vehicle for delivering messages and learning information that is well designed to help students do learning goals [13]. Meanwhile Haryoko [6] explains that educational media are tools, methods, and techniques used to increase the effectiveness, communication, and interaction between lecturers and students in the learning. Learning media that are believed to be suitable for forming spatial thinking skills in geography learning is by using the Geographical Information System (GIS) application.
Downs and De Souza on Marsh [12] suggest that GIS is a very useful tool in education as a support system for spatial thinking. According Wahyuningtyas [16] GIS is an effective tool for teaching an understanding of space and place so that it can be relied on in supporting spatial thinking skills. The existence of GIS in education helps students learn geography by practicing spatial thinking [1]. The use of GIS to produce social studies students cognitive mapping skills can be further refined through the association and correlation of the spatial distribution of phenomena.

2. Methods
The article aims to find the role of (GIS) in shaping social studies students spatial thinking skills in the analysis of geosphere phenomena. The data was obtained through a literature study obtained from published journals and earlier electronic research articles. The procedure for writing this article was done by examining, comparing, and interpreting journal studies and research articles. This technique is used to determine the validity of the data under study based on the context. Data analysis was performed using qualitative descriptive analysis techniques.

3. Results and Discussion

3.1. Spatial Thinking Skills and Geosphere Phenomena
The spatial thinking process is a universal way of thinking that can be practiced by all people at different levels and contexts. Wahyuningtyas [16] argue that the ability to think spatially is important because it is an inseparable part of everyday life. Through the use of digital mapping tools, global positioning systems (GPS), and vehicle navigation by the community, it means that they are aware of the possibility of spatial data [19]. In essence, spatial thinking is a constructive combination that includes 3 components, namely the concept of space, means of representation, and the process of reasoning [17]. Spatial thinking depends on understanding the meaning of space and utilizing the nature of space to manage problems, find answers, and uncover solutions to these problems. In the process of visualizing the relationships in the spatial structure, it allows students to be able to see, remember, and analyze static properties through the transformation of the dynamic properties of objects in space and the relationships between spaces.

Spatial Thinking is an important aspect of understanding geosphere phenomena. Almost all geosphere phenomena can be understood from a spatial point of view, both physical phenomena and social phenomena. Geosphere phenomena in the study of geography subjects consist of phenomena of the lithosphere, atmosphere, biosphere, anthroposphere, and biosphere. Various phenomena on the earth's surface can be studied through geography. The study of geosphere phenomena in geography learning certainly requires help in the form of spatial thinking skills and of course requires help in the form of learning media. Geography learning media which characterizes it, namely maps. The use of this media has a positive influence on spatial thinking skills.

Maps have become one of the media commonly used supporting geography learning in social studies program to date. This media can describe and visualize the geosphere phenomena that occur. The type of map that is most effectively used today is in the form of a digital map that can be generated through processing spatial reference data, one of which is by using GIS [16]. Information technology support such as Geographical Information Systems (GIS) can offer affordability to social studies students to easily study various geosphere phenomena. Through mapping processed from GIS, it is easy to map various geosphere phenomena, such as through GIS which can be used by social studies students to map flood volume levels in DKI Jakarta. This means that with GIS students can get an overview of the geosphere phenomenon (flood) that occurs. Besides, students can study and analyze geosphere phenomena by connecting one space to another. For example, analyzing the geosphere phenomenon of flooding by connecting the distribution of space that has the potential to be affected and its causes, as well as its impact on the socio-cultural conditions of the surrounding community. This means that spatial thinking skills are needed which will be formed indirectly but through analysis of several causes and predicting their impact.
Analyzing geosphere phenomena using GIS aims to do the spatial context of geography learning on earth. Geography learning in the social studies program is important to pay attention to in the formation of spatial thinking skills in students. So that geography learning does not only know information about these phenomena but also understands correlation. The formation of spatial thinking skills in geography learning can be demonstrated by the ability to decide spatial correlations that occur between one spatial and another in a geosphere phenomenon. According to Star and Estes in their research journal [5] entitled Remote Sensing and Geographic Information Systems and Their Applications in the Field of Education and Development that understanding the natural environment and its symptoms (including natural disasters) can be done through the application of the “4M” concept. The "4M's" include Measurement, Mapping, Monitoring, and Modeling. Remote sensing data is an important response in GIS because the data is always up to date, complete, and quickly obtained. Examples of the application of GIS in analyzing geosphere phenomena such as those occurring in floods in DKI Jakarta through the “4M” concept, namely: measurement through flood volume measurement, mapping through rainfall mapping activities, monitoring through waste monitoring activities in the context of environmental sustainability, and modeling through selecting locations for residential areas sustainable for the less fortunate. The example of the flood problem in DKI Jakarta illustrates the role of GIS in shaping spatial thinking skills. Through the use of GIS, it is hoped that social studies students will be more familiar with the conditions of the surrounding environment from various aspects, both from threats, vulnerabilities, and disaster risks.

3.2. The Role of GIS in Forming Students Spatial Thinking Skills

Geographical Information System (GIS) consists of input, database preparation, process, and output. As input, all spatial data can be used as input, such as available maps, census data, determination results, and remote sensing images [5]. Based on these arguments, it can be understood that GIS has an important role in the process of geography education whose main object is the earth's surface which includes (lithosphere, hydrosphere, atmosphere, biosphere, and anthrophosphere GIS facilitates spatial formation). The intelligence includes the ability to read maps (map literacy), the ability to transform life into visual images. Spatial thinking can be a means to formulate problems, find problems, impacts, and convey solutions related to geosphere phenomena that occur. Thinking is also useful and helps in decision making from simple problems to complex problems [16], [18]. Therefore, this spatial thinking needs to be applied to students to solve geography learning problems.

GIS has a significant role and benefits, this can be seen when detecting, identifying, mapping, measuring, analyzing geographic objects and geosphere phenomena, resources and the environment that can be done through GIS support software. GIS provides opportunities for students to explore their environment by using new technology [16]. GIS supporting software technology, such as ArcMap, through this software spatial reference data is processed input, processed, manipulated and modeling can produce output in the form of a digital map and can be printed. Various GIS changes have been packaged in learning media that can display spatial patterns from various environments, geopolitics and social, cultural, economic and can analyze the process of change and the interaction of an event which is the key to understanding spatial concepts in geography learning.

According to Downs and DeSouza on [12], GIS is a very useful tool on the world of education as a support system to support students who have spatial thinking skills. According to him, the key to spatial thinking consists of three elements, namely: the nature of space, the means or means of presenting spatial information, and the process of giving reasons. The importance of understanding the meaning of space, such as size, sequence or continuity, proximity, separation, etc., can be a means of formulating problems, finding answers, and conveying solutions. The importance of GIS is used in the social studies program so that can improve the quality of learning about spatial.

One learning model that applies GIS is PBL-GIS (Problem Based Learning Geographic Information System) which reflects five geographic skills called Geography for Life: 1994 National Geography Standards, Geography Education Standards Project, namely asking geographic questions,
obtaining geographic information, organizing geographic information, analyze geographic information and answer geographic questions [3], [9].

The relationship between PBL-GIS and the five geographic skills is as follows[20]:

1. Geographical skills in asking geographical questions related to PBL-GIS, on the selection of problems with a spatial or geographic focus and express it in one more inquiry question and compile a research plan.
2. Skills in obtaining geographic information related to the PBL-GIS model which includes collecting primary data from observations, fieldwork, GPS. Find existing secondary data sets and digitize maps.
3. Skills in organizing geographic information related to the PBL-GIS model where activities take place in organizing data in a spatial database, creating GIS, selecting and designing appropriate maps and charts, and exploring geographic relationships.
4. Skills to analyze geographic information in the PBL-GIS model, which is related to the activities of performing queries, data exploration, analysis, synthesis, evaluation, and explaining GIS. Load conclusions (make inferences) and draw conclusions.
5. Skills in answering geographic questions related to the PBL-GIS model whose activities summarize findings, offer possible solutions to problems, formulate valid generalizations of geographic search results, and show current learning and results.

[19], [8] describes three reasons for the strength of the introduction of GIS in education:

1. The educative rationale: IG Science and GIS support geography teaching and learning.
2. The place-based rationale: GIS is an ideal tool to use in studying geographic problems at various scales.
3. The workplace rationale: GIS is an important tool for knowledge workers in the 21st century.

Several other reasons that support the need for GIS in geography learning are described by [7] as follows:

- The need for GIS learning is based on the argument that GIS improves students' spatial thinking skills.
- Driving factors in GIS learning offer students the opportunity to explore their environment using new information technologies.
- Allows students to search (query), visualize, and manage spatial databases.
- Use of GIS, enabling inquiry-based learning strategies and critical thinking.
- In particular, GIS can help increase the ability to analyze, synthesize, and check geographic information.

Unfortunately, the reasons that support the application of GIS in geography learning do not attract many lecturers. Many lecturers stated that there were obstacles and challenges in introducing GIS in education. According to the research by [2], the main follows:

- In lecturer training, the application of GIS is not a core item.
- Non-geography, which leads to lecturers with limited knowledge of pedagogical content, results in fewer lecturers recognizing the potential opportunities that GIS offers to teach geography content and skills.
- Free data availability and easy-to-use software.
- Students attitude. It seems difficult to persuade students’ to use new technology if it is very technically demanding and if students’ are not completely confident in its effectiveness and added value.

The efforts to solve problems that pose challenges in implementing GIS in education. [19], [14] makes three recommendations, including:

1. Address the main internal problems associated with implementing GIS: lecturers dan students’ training, availability of user-friendly software, ICT equipment. It is a matter of developing software that is easier to use with data access. As [4] concludes in his work on GIS software
program analysis: “GIS user interfaces remain complex, difficult to learn and use, and lack a consistent conceptual or theoretical framework.

2. Use a community of learners approach.

3. Instituting GIS into curricula, ensuring that GIS is aligned with significant general learning objectives such as graphics, critical thinking, and citizen skills.

4. Conclusions

Geographical Information System (GIS) plays an important role as a support system and facilitator in map literacy skills to shape and improve social studies students spatial thinking skills in geography learning. One of the GIS applications in geography learning is the analysis of geosphere phenomena. Geosphere phenomenon in the content of geography subjects consists of phenomena of the lithosphere, atmosphere, biosphere, anthroposphere, and biosphere. GIS provides an opportunity for students to explore geosphere phenomena in the surrounding environment with technology. The use of GIS in social studies programs is expected to improve spatial thinking skills so that students can better recognize the surrounding environmental conditions from various aspects both from threats, vulnerabilities, and disaster risks. Unfortunately, there are still several obstacles in implementing GIS, such as the availability of free data and easy-to-use software and students’ skill reluctance into new technology. Solutions that can be used to meet these challenges include implementing students training, developing software with free data access, and using a student community approach. This solution must be implemented so that GIS can play a role in shaping spatial thinking skills.

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