The carrying capacity of GIS application for spatial thinking growth in disaster material

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Abstract. Spatial thinking skills must be mastered by students. This is very important because this concept is the main character in studying geography. On the surface of the earth, some things become problems related to natural conditions that can be solved by those who can to think spatially. This ability to think spatially can be applied by students in terms of analyzing areas prone to disasters. In principle, they must be able to understand how the characteristics of a region that has a high vulnerability to disasters. To further facilitate and sharpen their analysis, data that is capable of supporting can be used to produce the new information needed. These data can be facilitated well through image data processing software and Geography Information System (GIS). The method used in the assessment of this problem is qualitative descriptive. Based on the results, of the analysis it can be concluded that spatial thinking skills is at the core of achievement in geography learning. GIS provides an opportunity for students to explore their environment by using new technology. Therefore, in the future, it can be used increased as a critical thinking ability in a spatial. Increasing spatial thinking skills will enable students to get to know their own environment and the environment properly, which include recognizing the threat, the level of vulnerability of the region to the risk of disaster-prone, when a disaster occurs, students can help themselves, their families, and also the community.

1. Introduction
Disasters are phenomena that can cause harm. Disasters can occur due to natural or non-natural factors and also factors from humans. According to Law No. 24 of 2007 [11] said that disasters are events or series of events that threaten and disrupt the lives and livelihoods of people caused by natural factors and/or non-natural factors and human factors resulting in human casualties, environmental damage, losses property, and psychological impact. Disasters occur due to natural factors such as earthquakes, tsunamis, floods, tornadoes, and also volcanoes erupt.

As a country surrounded by active mountains or commonly called the ring of fire. Indonesia is one example a country with a variety of impacts caused by disasters. The ring of fire in question is an area that has or often experiences earthquakes and volcanic eruption. This is because the area surrounding the Pacific Ocean basin. In addition to being in the ring of fire region, the country of Indonesia is also above three continental plate collisions, namely the Indo-Australia, the Eurasian plate, and the Pacific which are in the south, north and east. With this condition, Indonesia has a vulnerability to disasters such as volcanic eruptions, earthquakes, and tsunamis.

As a result of this vulnerability, Indonesia should have a perspective on responding to disasters. What is meant is, human beings need to understand the characteristics of space as their place of residence. Space referred to in this case is nature. Nature that is a place to live is not only a media provider of resources for all creatures but also has the potential to become a disaster carrier. Indonesia, which in fact is a tropical country with sunshine throughout the year, with a line of thousands of islands, the wealth of beautiful marine biota, abundant forest biodiversity, volcanoes that almost exist in all regions of Indonesia, is a sign that the country's soil and natural fertility is abundant. A narrow
perspective and not accompanied by good thinking can give birth to minimal and low awareness, indifference and indifference, and ineffective actions because they are carried out without the knowledge and of their own volition. A perspective like not infrequently still covers most of our society.

In Iran, a number of disasters that have befallen this region make people have a good perspective in responding to disasters. The Iranian government makes aware of disasters as a new development in the world of education. Some of them have been done both in formal and informal education. As with special disaster studies poured in textbooks, the film "national safety earthquake training" was produced for children of all ages, writing and drawing competitions and disaster-related exhibitions, and disaster posters in the educational environment, as well as using songs, games, technical puzzles, and other related ones in educational tools [5].

Reflecting on what the Iranian government is doing, it is time for countries with high vulnerability to disasters such as Indonesia to think about how to manage the impacts or risks posed by disasters interrogating in the management of development. Management of development, in this case, is not something that is intended by the management of a disaster. However the development referred to in this case is development in reducing threats and the potential that can be caused due to a disaster. One way that can be done in managing this development is by going through school or education. Therefore, learning about a disaster is very necessary for children in school. Just like what was done in education in Iran, where after Yokohama Strategy (1994-2004) and HFA (2005-2015), in the application of education renewing and using novel media and highly recommended tools. In addition, the use of simulators can be done practically which can make children more sensitive to earthquakes. Expansion of disaster training can also be done. This is because children prefer to be involved in this kind of activity. This exercise can be done randomly at school without prior notice, so students will be included in more realistic situations to show their true level of readiness [3,13].

In addition to the world of education, the role of mass media in introducing programs for children with the theme of disaster preparedness is also important in order to make children and their families aware. This mass media will provide benefits that are fairly easy and fast because they are around the community and they have easy access to them.

At the national level itself, in the 2010-2014 National Disaster Management Plan (RENAS PB), several plans for activities related to disaster management have been mentioned, namely the integration of disaster management knowledge elements in the school curriculum; implementation of disaster preparedness programs in schools; and increasing resource capacity for disaster education is included in research, education and training programs [1]. BNPB Head of Data, Information and Public Relations Center, Sutopo Purwo Nugroho, said that to accommodate disaster education, Geography is used as a platform for social studies at elementary / MI and junior high / MTs levels. As for the levels of high school, vocational, and MA in Geography, it will be easier to accommodate disaster education because it stands alone as a monodisciplinary [4].

In the world of education, there are developments that become interesting things to be studied more deeply related to Geography subjects. This is related to the study of spatial thinking skills in students or spatial thinking skills. [6] States, "spatial literacy", is "undervalued and therefore less taught." Even though some technological developments have made geospatial applications an interesting electronic toy, this has become a study that can be considered to develop students' spatial thinking skills in geography learning. One application that can be utilized is the Geography Information System (GIS).

Geography Information System (GIS) is an effective tool to teach an understanding of space and place. GIS can be used as a tool in assisting various fields of natural sciences, sociology, anthropology, political science, economic and urban studies for archeology and history. The use of this tool allows the introduction of research methods in geography teaching, for example, to gain the ability to create a conceptual model of reality that can be learned and to select the data that is most useful for this purpose, to interpret it independently, and to represent it effectively.

2. Methods
This research method used a qualitative descriptive approach. According to Moeleong [9], qualitative research is a study that produces descriptive data in the form of written or oral words from the form of one's actions. Library techniques are also used in this study as data support. Literature is used to obtain
various information and concepts that are relevant to research related to geography learning, GIS, spatial thinking skills and others through sources of literature and journal articles.

3. Results and Discussion

3.1. Geography Learning, GIS and Spatial Thinking Skills

The ability to think spatially is an important characteristic of geography learning. The geography that discusses occurring phenomena does not just explain what and where the phenomenon occurs, but in learning also examines how the process of the occurrence of phenomena, shapes, sizes, directions and also the pattern of the occurrence of a phenomenon as well as how the relationship of phenomena to one another. Spatial thinking will be useful and helpful in making decisions from simple things to complex problems. Therefore, this spatial thinking needs to be applied to students in order to solve problems in geography learning.

[7] States that the effectiveness of earth education should focus on spatial thinking so that students understand spatial patterns, linkages, and relationships. Spatial thinking can be supported by a system that can provide information, showing a problem with various types and levels of ability. This, of course, is also supported by the amount of data that already exists. The system that can help with this is the Geography Information System.

GIS is a system that has a reliable ability to support spatial thinking skills. This is because in GIS there is integration between software and hardware and procedures in the ability to process data. According to ESRI, Geographic Information Systems (GIS) is a framework for collecting, managing and analyzing data. Starting from geography, GIS can integrate many types of data. In this case, it is to analyze the spatial location and arrange the information layer into visualization using maps and 3D scenes. With this unique ability, GIS is able to reveal deeper insights about data, such as patterns, relationships, and situations that help users make more informed decisions. [7] Stated that schools with students using GIS scored higher in spatial analysis tests compared to students who in learning used traditional methods. The strength possessed by the Geography Information System is the formation of a spatial output in the form of information from the results of database analysis, through the process of GIS. Such processes include attribute data processing, geographic data processing, and also integrated graphics data and attributes.

The National Research Council formulated the importance of "Learning to think spatially". Down et al in [13] explained that people who have spatial literacy have the following characteristics:

- Students have a habit of thinking spatially, they know where, when, how, and why they must think spatially,
- Students can practice spatial thinking informally, where they have extensive and extensive spatial knowledge of concepts (such as distance, direction, scale, and arrangement and representation (maps, 3D models, graphs),
- Students can adopt a critical attitude towards spatial thinking and evaluate the quality of spatial data, he can use spatial data to be constructed and articulated.

Spatial thinking is an integral part of everyday life. Spatial ability according to [8] consists of spatial visualization, spatial orientation, and spatial relations. As with using online mapping, navigation and GPS tools in human cars, we have realized the possibility of spatial data. This shows that it is the concept of space that makes spatial thinking a different form of thinking. According to the National Research Council, spatial thinking requires knowledge of:

- Spatial concepts, namely various ways of calculating distance, coordinate systems, and the nature of space into two and three dimensions. It also includes relative locations, proximity concepts, intersections, and regions.
- Spatial representation, namely the relationship between views: orthogonal versus perspective maps, effects of projections, graphic design principles.
- Spatial reasoning, namely various ways of thinking about the shortest distance, ability to estimate and interpolation, estimate the slope of a hill from a contour line map.
3.2. The Role of GIS in the Formation of Spatial Thinking Skills in the Context of Disaster Learning

Table 1. Linkages of PBL-GIS with Five Geographical Skills

| Skills of Geography                  | PBL-GIS                                                                 |
|--------------------------------------|-------------------------------------------------------------------------|
| Ask geographic questions             | Select a problem with spatial or geographic focus and express it in one more inquiry question (inquiry questions). Organizing a research plan (a research plan) |
| Acquire geographic information       | Collect primary data from observations, fieldwork, GPS. Place existing student data sets. Digitized maps (Digitize maps) |
| Organize geographic information      | Organizing data in spatial / GIS databases; Making GIS, selecting appropriate map and graph design forms; explore geographic relationships (explore geographic relationships) |
| Analyze geographic information       | Search (queries), explore data, analyze, synthesize, evaluate, and explain GIS. Contain conclusions (make inferences) and draw conclusions (draw conclusions) |
| Answer geographic questions          | Summarize the findings, offer possible problem solutions, and formulate valid generalizations from geography search results. Reflect on learning and present results |

Source: [2]

The formation of spatial thinking skills does not appear or grow by itself. This ability to think spatially arises because of a spatial problem that occurs in the environment. People who often find it easy to believe in an issue or news circulating in the mass media will tend to feel anxious and fearful without knowing the truth. The emergence of this attitude can be caused because of the outcomes of geography learning that have not arrived or hit the level of spatial thinking skills. Some types of GIS applications such as ArcGIS in the form of desktops can help students grow spatial thinking. According [2] the reason for the importance of GIS is used in the school curriculum which is able to improve the quality of learning about spatial, but this will be a bit complicated in its application in high school education because not all school institutions have tools that support it for implementation. Moreover, it is also supported by not all educators have the ability to operate this GIS system.

From the tables that have been presented, it can be one of the solutions in applying GIS-based geography learning, but PBL-GIS used in this case is GIS with Web-based, especially the Google Earth application. The application can facilitate by displaying images in 3D form, altitude profile of a place, as well as historical imagery, [10]; in [12] for example, using the time slider on Google Earth to see an event at a time. Students can prove or match an issue with the time slider search results in Google Earth. To better understand the details of an event, students can use a display or feature with a height profile. Students can find out this by using the facilities available in the Google Earth application. Existing 3D sighting profiles can be used to predict the impact of a disaster, such as the following picture:
3.3. Integrating Spatial Thinking Capabilities Using GIS in Education

The introduction of GIS in education has been debated by three reasons which include complementarity with seeing the capabilities possessed by GIS [14].

GIS Strength:
- Educational reasons: GI and GIS science support geography teaching and learning.
- Place-based reasons: GIS is the ideal tool to be used to study geographical problems at various scales.
- The rationale for the workplace: GIS is an important tool for knowledge workers in the 21st century.
According to Van Leeuwen and Scholten in [14] the added value generated using GIS-based on five meanings:
1. Sense of reality, which uses realistic data. For example, in its own environment students can make a spatial theory from abstract to something real.
2. A sense of urgency, using realistic data and thematic items will make students more interested.
3. A sense of experience, using GIS students will have experience and also the opportunity to then visualize today and view later on which of course is influenced by their own decisions.
4. Sense of fun, students will enjoy what they do and use GIS is a fun thing because it is supported by interesting data.
5. Sense of location, by using GIS in a combination of GPS routes, for example tracking a location will provide extra dimensions, such as students can find out the coordinates of a place, this, of course, will also make students interested.

4. Conclusions
The ability of spatial thinking possessed by students is one important thing to have. Spatial thinking is at the core of achievement in geography learning. This can be helped by the use of a Geographic Information System that is aligned in supporting the development of spatial thinking. The Geography Information System provides opportunities for students to explore their environment by using technology. Therefore, in the future, it can be used as a critical thinking ability in a spatial. Increasing spatial thinking skills will enable students to get to know their own environment and the environment properly, which include recognizing the threat, the level of vulnerability of the region to the risk of disaster-prone, when a disaster occurs, students can help themselves, their families, and also the community.

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