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# The Impact of *Science, Environment, Technology, and Society* (SETS) Learning Model Integrated with *Google Earth* on *Spatial* Thinking Ability in Senior High School

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**ABSTRACT**

Developing spatial thinking skills in students often poses a challenge for Geography teachers in Indonesia. The concept of spatial relationships in geography places spatial thinking as a distinct aspect of intelligence, enabling individuals to identify patterns and trends in spatial change. Therefore, appropriate models and strategies are needed to develop spatial thinking skills. This study aims to determine the effect of the *Science, Environment, Technology and Society* (SETS) learning model integrated with *Google Earth* on students' spatial thinking ability. This research is a *quasi-experiment* with *posttest-only* design *nonequivalent groups* that uses a quantitative approach with the inferential statistical method using the *Independent sample t-test* parametric test. The subjects of this study were randomly selected XI grade students from SMAN 10 Malang including, XI-C class as the experimental class and XI-D as the control class. The research instruments used are seven essay questions on spatial thinking ability. The data obtained will be analyzed using parametric statistics *Independent sample t-test* and obtained sig value. (2-tailed) 0.041. The mean value of the experimental class is greater (80.14) than the mean value of the control class (72.08). It can be concluded that the *Science, Environment, Technology, and Society* (SETS) model integrated with *Google Earth affects* students' spatial thinking ability on the material of Disaster and Environment class XI SMAN 10 Malang City. Another finding of this study is that three syntaxes are dominant in bringing up and developing students' spatial thinking ability, namely initiation, concept development & formation, and concept application.

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## 1. Introduction

Geography is considered an integrative science that complexly combines geospheric, encompassing generalization of both social and physical events (Sejati et al., 2022). Moreover, the study of geography is correlated with material and formal objects to develop spatial thinking skills (Bekti Susetyo & Komang Astina, 2017). This condition is considered important, so students need to be trained to understand spatial perspectives to comprehend problems and changes in geospheric phenomena (Ervina et al., 2022) .This is in line with one of the main objectives of geography learning, which is to provide spatial thinking skills so that students can understand geography learning well (Wijayanto et al., 2020).

Spatial thinking ability plays a pivotal role in geography instruction. These abilities enable students to analyze and plan for spatial regions, effectively present their findings, and comprehend the interplay between geographical concepts and human activities. One of the fundamental underpinnings of geographic literacy is the ability to think spatially (Collins, 2018) Moreover, these skills serve as a primary objective as they enhance students' understanding of the location and interconnectedness of geospheric phenomena (Ridha et al., 2020). Spatial thinking ability stands as a core competency that students must attain to delve deeper into a study of geography (Metoyer & Bednarz, 2017). Spatial thinking differs from other cognitive abilities in its emphasis on comprehending geographical changes through spatial depictions and analyses (Wijayanto et al., 2020). Additionally, students equipped with spatial thinking abilities can effectively observe, analyze, and accurately describe geospheric phenomena (Wijayanto et al., 2020). In this case, the teacher is required not to eliminate the intensity of geography by paying attention to the achievement of spatial thinking ability in students.

Despite its significance, current geography instruction in schools falls short of fostering comprehensive spatial thinking ability among students. Based on interviews and observations conducted with geography teachers at SMAN 10 Kota Malang, it is evident that geography lessons still predominantly employ a teacher-centered approach, utilize teaching models that are not aligned with students' needs, and select supporting media that fail to stimulate spatial thinking abilities. Furthermore, high school geography education remains confined to conventional teaching methods (Saputra, 2022). Broadly speaking, geography learning requires an integrated teaching model that incorporates innovative technology, as educators currently lack the necessary models and media that resonate with students' needs. This deficiency hinders the full potential of students' spatial thinking development. In light of these challenges, the implementation of a *Science, Environment, Technology*, and *Society* (SETS) teaching model integrated with Google Earth presents a viable solution to enhance students' spatial thinking ability.

Recognizing this opportunity, the *Science, Environment, Technology, and Society* (SETS) learning model integrated with *Google Earth was* chosen as a solution to improve students' spatial thinking ability in Geography learning. The syntax of the SETS model consists of 1) initiation, 2) concept development, and formation, 3) concept application, 4) concept stabilization, and 5) evaluation. These stages serve as strategies to facilitate students' activities in developing ideas, concepts, and notions of geosphere phenomena in a spatial context. The SETS learning model has several advantages, including Firstly, it can stimulate student activity so that student learning motivation increases and can develop scientific attitudes (Made Sudarmawan et al., 2020). Scientific attitude is interpreted as students' ability to analyze problems systematically through research and observation. Secondly, the SETS model learning steps can increase active student participation in the classroom. Third, this model can increase activity, creativity, and the ability to write scientific ideas and ideas that are by field conditions (Fatchan et al., 2014)

On the other hand, the SETS learning model also has weaknesses, namely that in the design process this model takes a long time to achieve maximum results. Teachers must study in depth the preparation of evaluation tools, material maturity, and learning tools that can fully facilitate students. One of the important learning tools is learning media. Technological advancements play an important role in the development of education so technology needs to be accommodated into the learning system to facilitate students in the learning process (Effendi & Wahidy, 2019). By leveraging technology in education, we can create a learning environment that supports constructivist approaches, there by empowering students to meet the demands of a globalized society (Aliman et al., 2019)

*Google Earth is* a form of geospatial technology that can provide detailed, up-to-date, and authentic geospatial information in large quantities with good speed capacity, flexibility, and ease of use (Favier & Van Der Schee, 2014). The integration of *Google Earth* into the SETS model stimulates spatial thinking ability by enabling students to visualize phenomena through observations of changes occurring on the Earth's surface (Bachri & Handoyo, 2022). *Google Earth* can be implemented in the syntax of initiation, concept development & formation, and concept application. Previous research findings have demonstrated that the Science, Environment, Technology, and Society (SETS) model integrated with *Google Earth* enhances students' 21st-century thinking ability (Huda et al., 2023). Similar evidence has been presented in earlier studies, indicating that the SETS learning model has a positive impact on students' problem-solving abilities (Mayasari et al., 2023).

It can be proven that there is an influence of the SETS learning model integrated with *Google Earth* on the ability of students in Geography. Spatial thinking has emerged as a crucial cornerstone for improving students' geographical abilities, making it worthwhile area for further exploration (Bednarz & Lee, 2019). This research provides empirical evidence of the significance of integrating environmental issues and geospatial technology into geography education to enhance spatial thinking. The study contributes to the improvement of spatial thinking abilities through the development of valid assessment instruments and the design of assignments to measure students' spatial thinking competencies. While extensive research has been conducted on the implementation of the SETS model, this study's novelty lies in its focus on the SETS model integrated with *Google Earth* as an independent variable and its association with the dependent variable of students' spatial thinking ability. This novelty also lies in the difference in material, subject, and research location.

## 2. Method

### 2.1 Research Design

The study employed a *quasi-experimental* research design with a *posttest-only nonequivalent groups design*. Two research subjects were involved, namely two classes from SMAN 10 Malang City. Out of three Grade XI classes, two classes were selected as the control and experimental groups. These two samples were chosen using a *purposive random sampling* technique from classes with relatively similar academic abilities. The average score was taken from the results of the daily exam, which were 85.14 for Grade XI C and 81,14 for Grade XI D. Subsequently, the experimental and control classes were randomly assigned. A total of 36 students from class XI C was the experimental class and 36 students from class XI D was the control class.

Both groups were administered a post-test with different treatments to assess the spatial thinking ability of class XI students at SMAN 10 Kota Malang on the topic of *Disaster and Environment*.

## 2.2 Research Procedures

The *Science, Environment, Technology, and Society* (SETS) model integrated with *Google Earth* was implemented in the experimental class, while the control class used a conventional model assisted by interactive *PowerPoint.* The data required in this study are the post-test scores of spatial thinking ability and student activities. The researcher will observe students' behavior in the planned learning to determine student achievement and the implementation of the applied syntax. To facilitate observation, this study is equipped with several learning devices, namely teaching modules for experimental and control classes, *e-modules*, Group Worksheets (LKK), Individual Worksheets (LKI), and evaluation tools. The evaluation tool consisted of seven essay questions based on spatial thinking ability indicators according to *Jo and Bednarz (2010)*. The obtained post-test score data will be analyzed using hypothesis testing quantitatively using inferential statistical methods with the independent sample t-test. The *Science, Environment, Technology, and Society* learning integrated with *Google Earth* employed five learning steps. The details of the steps are as follows Table 1.

**Table 1.** Syntax of *Science, Environment, Technology and Society* (SETS) Model *Google Earth* integrated

| Stages | Teaching Personnel Activities | Learner Activity |
|---|---|---|
| Initiation | The teacher provides *issues* and stimulus related to the interesting fact that Indonesia records the most devastating natural disasters in the World as well as the reasons for the high vulnerability and risk of natural disasters in Indonesia. | Learners explore, examine, and analyze problems in the form of causes and effects of the distribution, risks, threats, and vulnerabilities of natural disasters in Indonesia using *Google Earth* map projections. |
| Establishment Concept Development | 1. The teacher explains the process of tectonic, volcanic, and hydrometeorological natural disasters.<br>2. The teacher explains the relationship of Indonesia's landforms and morphology to the risk of natural disasters in Indonesia. | 1. Learners develop and interpret problems by examining the distribution, types, and causes of natural disasters through visualization of *Google Earth* map projections. *(Case Study:* Java, Bali, Sumatra, Kalimantan, Papua, Sulawesi)<br>2. Learners explore the geological conditions, morphology, climate, and human activities that can be a risk of natural disasters in Indonesia. |
| Concept Application | The teacher gives students an assignment worksheet related to the distribution of disasters.<br>The teacher explains the correct disaster mitigation process based on the *Disaster Management Cycle.* | 1. Learners make observations through morphological analysis on *Google Earth* and literacy, problem formulation, analysis & refinement of thinking.<br>2. Learners can formulate disaster mitigation (pre and post-disaster) correctly based on the *Disaster Management Cycle*, through observation of physical and social conditions in an area. |
| Stabilization Concept | The teacher assigns a task to organize the results of the assignment systematically. | Systematic report writing and presentation of results. |
| Evaluation | Reflection and Assessment. | Reflection and Assessment. |

## 2.3 Data Collection and Analysis

Before conducting the research, a research instrument was developed to measure students' spatial thinking ability variables. The instrument was tested for validity using *Pearson Product Moment* correlation (*Bivariate Pearson*) and for reliability using *Cronbach's Alpha*. The results of the instrument validity test showed that the calculated r value was greater than the table r value, so the research instrument was declared valid and could be tested in the research class. The result of the results test showed that the alpha value was greater than the table r value, which means that the instrument has consistency. Furthermore, the data obtained in the research will be tested for prerequisites using the *Kolmogorov-Smirnov* test for normality and *Levene's test for equality of variances* for homogeneity, both of which have a significance value of > 0.05. The final step is to conduct a quantitative hypothesis test using the parametric *Independent sample t-test* statistical inference method. This calculation was carried out with the assistance of *SPSS 25 for Windows.*

## 3. Results and Discussion

### 3.1 Validity and Prerequisite Tests

The data collection instrument for this study employs seven post-test questions aligned with the developed spatial thinking indicators (Jo et al., 2010). The instrument will undergo validity and reliability testing. This test aims to determine the instrument's validity level and assess the instrument's consistency (reliability) in measuring a variable. The instrument validity testing utilizes the *Pearson Product Moment* correlation (*Bivariate Pearson*) assisted by *SPSS 25 for Windows.*

**Table 2.** Validity Test of Student Spatial Thinking Ability Post-test Instrument

| Item No. | *Pearson Correlation* | Conclusion |
|---|---|---|
| 1 | 0.413* | Fairly Valid |
| 2 | 0.653** | Valid |
| 3 | 0.785** | Valid |
| 4 | 0.401* | Valid Enough |
| 5 | 0.459** | Valid Enough |
| 6 | 0.665** | Valid |
| 7 | 0.819** | Very Valid |

**. This is a lower bound of the true significance*

***. This is a higher bound of the true significance*

Based on Table 2. The validity test results yielded Pearson Correlation coefficient (significance) values ≥ 0,05 indicating that the instrument is reliable. It can be concluded that the research instrument is valid and can be tested on both experimental and control groups. The next instrument analysis is the reliability test. The reliability test was calculated using *Cronbach's Alpha* assisted by *SPSS 25 for Windows.* The result of the reliability test shows an alpha value greater than the r table value (0.723), indicating that the instrument was reliable.

Before analyzing the data collected in the study, prerequisite tests were conducted using normality and homogeneity tests. This was done to ensure that the data analysis process was more relevant and produced high-accuracy results. The following are the results of the normality test for the research data.

**Table 3.** Normality of Research Data

| | *Kolmogorov-Smirnov* | | | |
|---|---|---|---|---|
| | Class | *Statistic* | Df | Sig. |
| Spatial Thinking Ability Test | *Science, Environment, Technology, and Society* Integrated with *Google Earth* | .131 | 36 | .119 |
| | Conventional | .121 | 36 | .200 |

Based on Table 3. The normality test results for the research data on students' spatial thinking ability were obtained using the *Kolmogorov-Smirnov test.* The implementation of the *Science, Environment, Technology, and Society* (SETS) learning model integrated with *Google Earth* in the experimental class had a significance level greater than 0.05 (0.119> 0.05). Meanwhile, the implementation of the conventional model assisted by *PowerPoint in the* control class had a significance level greater than 0.05 (0.200 > 0.05). From the results obtained, it can be concluded that the research data in the experimental class and control classes are normally distributed.

**Table 4.** Homogeneity of Research Data

| SETS learning model integrated with *Google Earth* | *Levene Statistic* | *Dfl* | Df2 | Sig. |
|---|---|---|---|---|
| | .747 | 1 | 70 | .390 |

Based on Table 4. it is found that the significance value is greater than 0.05 (0.390> 0.05). The results of the homogeneity test show that the variance of the data on spatial thinking ability between the experimental class and the control class is homogeneous. The results of the prerequisite test show that the research data is normally distributed and homogeneous so that the data can be analyzed using parametric statistics namely the *Independent sample t-test* on the *SPSS 25 for Windows* application.

### 3.2 Results of Students' Spatial Thinking Ability

The following are the average results of the *posttest* according to the indicators of students' spatial thinking ability in the experimental and control classes.

**Table 5.** Average Post-test Score of Spatial Thinking Ability

| Parameters | *Science, Environment, Technology and Society* Integrated with *Google Earth Model* | Conventional Model |
|---|---|---|
| Number of Students | 36,00 | 36,00 |
| Average | 80,14 | 72,08 |

Based on Table 5. The mean difference in *post-test* scores between the experimental class and control classes was 8.06. This suggests that students in the experimental group, who were taught using the *Science, Environment, Technology, and Society* (SETS) integrated with the *Google Earth* learning model, had significantly higher spatial thinking abilities. The research data were further analyzed to test the hypothesis of the study. Parametric statistics, specifically the *independent sample t-test,* were used for the analysis, with the assistance of SPSS 25 for Windows. The results of the *T-Test* analysis are presented in Table 6.

**Table 6.** *Independent Sample T-Test*

| Post-test Score | | *T-Test for Equality of Means* | | |
|---|---|---|---|---|
| | | t | df | Sig. (2-tailed) |
| Spatial Thinking Ability | *Equal Variances Assumed* | 2.083 | 70 | 0.041 |

In Table 6. Present the *posttest data on students'* spatial thinking ability, with a Sig. (*2-tailed*) value of 0,041, which is less than 0,05. This indicates that the H0 is rejected and H1 is accepted. Therefore, it can be concluded that the Sig. (*2-tailed*) is smaller than 0.05 and *the mean of the* experimental class is higher than the *mean of the* control class, then the *Science, Environment, Technology, and Society* (SETS) model integrated with *Google Earth* affects students' spatial thinking ability. The SETS learning model integrated with *Google Earth* becomes a fully progressive strategy by combining knowledge, environmental conditions, the use of technology, and community activities in Geography learning. Activities in the SETS learning model integrated with *Google Earth* can help students interpret ideas and ideas in real conditions to improve spatial thinking Ability.

### 3.3 The Effect of *Science, Environment, Technology, and Society* (SETS) Learning Model Integrated with *Google Earth* on Students' Spatial Thinking Ability

The SETS model integrated with *Google Earth* is a learning activity that focuses on deep thinking about the correlations between knowledge, environment, technology, and societal conditions through the use of geospatial technology. This model empowers students to identify problems using scientific inquiry methods, systematic thinking, and logical reasoning. In this research, scientific working methods are demonstrated by the student's ability to understand spatial hierarchy through the elaboration of the distribution of tectonic, volcanic, and hydrometeorological disasters based on the distribution of geomorphological zones in the regions of Java, Papua, Bali, Kalimantan, and Sulawesi. Through the discussion and presentation of the findings stages of the SETS model integrated with *Google Earth*, students actively engage in understanding the patterns of natural disaster distribution, assessing disaster risk factors, and applying reasoning processes, which are core indicators of spatial thinking related to disaster mitigation planning (Metoyer & Bednarz, 2017).

Students involved in various systematically arranged activities through the SETS learning syntax integrated with *Google Earth* and assignments in realizing spatial concept capabilities have been proven to improve their understanding of spatial frameworks. Assignments are tailored to address identified needs based on spatial thinking indicators to stimulate spatial thinking abilities through role-playing from the perspectives of knowledge, environmental awareness, adaptability to technology use, and understanding of their role as citizens (Ridha et al., 2023). Assignments should incorporate complex spatial concepts and encourage students to utilize geographic tools such as maps and geospatial information. The objective is to foster spatial thinking abilities through intricate geographic reasoning (Aliman et al., 2022). These assignments constitute one of the core activities in the concept syntax of the SETS model integrated with *Google Earth*. They encompass case studies of natural disasters in Java, Bali, Sumatra, Kalimantan, Papua, and Sulawesi.

Students are allowed to focus on assessing the risk and distribution patterns of natural disasters in Indonesia during the assignment process. One student analysis of disasters in East Java, titled "*Lapindo*", states that the Lapindo mud phenomenon occurred due to human negligence in exploiting natural as in the Porong, Sidoarjo region. Drilling strategy errors resulted in fluid mud eruptions in the vicinity of the mine, marshes, and residents' wells. The Lapindo disaster's impact was far-reaching, encompassing physical damage, destruction of clean water sources, the loss of Porong's socio-cultural heritage, and financial losses for the state and society. The analysis results were considered very good as they were able to touch on the correct answer key following the indicators of spatial thinking ability. Students were able to explain in detail the relationship of causal factors of the disaster, including geology, morphology, and anthropology in the disaster area. In addition, students were able to understand the core concept of spatial thinking through the study of changes in the geosphere through the analysis of spatial changes caused by the Lapindo mud disaster (Wijayanto et al., 2020).

The final student activity culminates in the presentation of findings by study groups. Through these presentations, students conclude *disaster risk* and *distribution patterns of natural disasters that are different* in each region due to different morphological, geological, and climatic conditions, and human activities in each region. This understanding serves as the primary framework for developing spatial thinking concepts in disaster education. Through this framework, students can demonstrate their cognitive abilities in decoding, analyzing, and evaluating information via a three-stage process: input, process, and output. Ultimately, students can easily comprehend the causes and effects of natural disasters based on spatial hierarchies. This conclusion reflects the students' understanding of spatial thinking indicators in the form of spatial concepts (Ridha et al., 2023). Moreover, students propose appropriate disaster mitigation strategies based on the *disaster management cycle* concept. This entire process fosters spatial thinking abilities and enables students to achieve higher-order thinking, aligning with the views of (Lee & Bednarz, 2012; Nguyen et al., 2019) who emphasize that high-order spatial thinking should be integrated with spatial concept comprehension, use of representational tools, and the correct application of spatial reasoning processes.

The educational media feature employed in this learning activity is the application of *Google Earth* to facilitate students' visualization of a region's morphology. Students were able to effectively apply Google Earth according to the teacher's instructions, enabling them to easily identify disaster locations, and spatial relationships, and comprehend various forms of physical changes in a region. Google Earth has the potential to enhance students' spatial literacy through the analysis of physical conditions and spatial relathionship (Rahayu et al., 2019) .The integration of technology-based media can enhance active student participation in the classroom to achieve optimal outcomes (Silmi & Hamid, 2023). The flexibility and convenience of learning through technology can improve learning quality. *Google Earth* serves as a multi-resolution educational medium that provides spatial information, geo-referencing, and large-scale geospatial information. This aligns with the view (Santoso, 2022) that *Google Earth* can be a medium that develops spatial abilities through visualization of three-dimensional and two-dimensional morphological conditions. *Google Earth* media is implemented in three syntaxes: initiation, concept development & formation, and concept application.

The implementation *Science, Environment, Technology, and Society* (SETS) model integrated with *Google Earth* involves five main syntactical stages: 1) *initiation,* students are presented with a natural disaster phenomenon (tectonic, volcanic, and hydrometeorological) in East Java as a stimulus to explore, examine, and analyze the disaster phenomenon. Students are also introduced to *Google Earth* as a tool to visualize phenomena in a particular region. 2) *Concepts Formation and Development*, students are allowed to develop and interpret the causes and effects of the distribution of natural disaster phenomena in Indonesia. This stage provides students with opportunities to gather relevant information data through the use of technology and literacy related to related phenomena. 3) *concept application,* students are given problems that encourage them to conduct observations using *Google Earth* projections on disaster areas, formulate problems, analyze, and assess the causes and effects of disasters as seen through the climate, geology, anthropology, and geomorphology of disaster areas. The phenomena obtained will then be analyzed for mitigation forms by the *Disaster Management Cycle*. 4) *Concept Stabilization,* students can write the results of the analysis systematically into a complete report. 5) *Evaluation, the* teacher assesses or reflects to measure student learning achievement. Initiation syntax, concept formation & development, and concept application are the dominant syntax in training students' spatial thinking abilities. Meanwhile, the other two syntaxes serve to strengthen the spatial thinking ability that students have acquired in the previous three syntaxes.

The implementation SETS (*Science, Environment, Technology, and Society*) model integrated with *Google Earth* is designed to actively engage students in scientific inquiry activities. This model incorporates an *initiation* stage that involves students responding cognitively and affectively to disaster *issues*, ranging from general to specific. The responses elicited from students are represented in their analytical skills. Through this step, students can analyze that the causative factors of flooding in Malang City are the surrounding mountains that enclose the city compared to other areas. Students have correctly interpreted the fact that water always flows from high to low areas. In addition, students have an understanding of the role of infiltration, soil saturation, and human activities that can lead to flooding. All of these issues are examined comprehensively to build spatial thinking concepts (Gathong & Chamrat, 2019).

The acquired spatial thinking concepts are further reinforced through activities of developing and interpreting problems. Students will seek relevant data and information obtained through literature review and the utilization of Google Earth as a medium providing visualization of the physical conditions of the disaster-affected area. This is followed by students analyzing spatial relationship patterns that can be causal factors in the different distribution of natural disasters in Indonesia based on geomorphological, climatic, geological, and anthropological conditions. All experimental learning groups have obtained data on the physical conditions of the disaster area, including photographs of the disaster area's morphology, socio-cultural data before and after the disaster, and the causes of the disaster. All information data was obtained through literacy and observation on Google Earth projections. (Avci, 2014)

In SETS-integrated *Google Earth* learning, scientific inquiry activities are carried out in groups of 6 students. This group assignment aims to train communication skills in obtaining solutions to the problems encountered. After completing assignment one, experimental class students were able to explain specific locations and describe the morphological conditions of the area based on *Google Earth* projections. In addition, students are aware of the differences in regional characteristics that affect the pattern of natural disaster distribution, as well as the differences in the risk, vulnerability, and disaster threats in each region. This is followed by refining spatial thinking ability through Assignment Two. Students can formulate innovative disaster mitigation strategies by the disaster management *cycle* concept, which includes the phases of *disaster, response, rehabilitation, reconstruction, recovery, development, prevention, mitigation*, and *preparedness.* This finding aligns with the results of Chu et al. (2016) which demonstrated that the use of geospatial technology can enhance students' understanding of spatial hierarchies. However, in this study, the emphasis was placed on spatial patterns that contribute to disasters and the formulation of a more comprehensive disaster management cycle.

Spatial thinking is defined as students' ability to understand natural and social phenomena through a spatial perspective, using map projections as a representational tool. Spatial thinking plays a crucial role in disaster education, as it enhances students' understanding of the location, distribution, and interconnections of geospheric phenomena that contribute to natural disaster. The learning steps of the SETS model integrated with *Google Earth* provide students with the opportunities to explore, and understand spatial relationship concepts, and be able to articulate the ideas they created. The core of spatial thinking is a complex combination of spatial concepts, information data, and thought processes (Oktavianto et al., 2017)

**Table 7.** Posttest Based on Spatial Thinking Ability Indicator

| Spatial Thinking Ability Indicator | Spatial Thinking Ability Level | Sub Indicators | Experiment Class | Control Class |
|---|---|---|---|---|
| Space Concept | *Spatial Primitives* | Location | 80,56 | 83,33 |
| | *Simple Spatial* | Identifying the Region | 75 | 75 |
| | *Complex Spatial* | *Spatial Association* | 84,02 | 65,97 |
| Representation Tool | *Use* | Identifying the Content of Aerial Imagery Photos | 81,94 | 77,78 |
| Reasoning Process | *Input* | Elaborate | 80,56 | 86,11 |
| | *Processing* | Analysis | 79,62 | 73,14 |
| | *Output* | *Plan* | 78,47 | 59,02 |

Table 7 presents the spatial thinking ability scores per indicator for the experimental class. The indicator with the highest score in the experimental class is, "*Complex Spatial* in the form of *Spatial Association*". This indicator is the core concept of spatial thinking ability, where students can understand specific areas in the vicinity of natural disasters. By considering technological advancements and the morphological conditions of disaster-prone areas, students can formulate disaster mitigation strategies following the *disaster management cycle* concept, which includes the phases of *disaster, response, rehabilitation, reconstruction, recovery, development, prevention, mitigation,* and *preparedness.* The scores on the other indicators also show that the experimental class scores are higher than the control class, and some indicators have quite a high difference. The low scores of the control class compared to the experimental class may be due to the fact the control class students are still unable to grasp the main keywords in the answer key, while the experimental class students can answer questions completely, more innovatively, and precisely.

The use of the integrated SETS model with *Google Earth* in class XI C shows that this model affects students' spatial thinking abilities. This can be seen from the average spatial thinking ability score and the spatial thinking ability per indicator of the experimental class higher than the control class (Tables 6 and 7). The experimental class students have a better understanding of the concept of spatial hierarchy, as evidenced by their accuracy in completing assignments well, and their ability to accommodate the four SETS concepts: *Knowledge, Environment, Technology, and Society*.

In contrast, the control class, which implemented a conventional model using discussion, lecture, and question-answer methods, only focused on the teacher (*teacher-centered*), while the experimental class focused on the students (*Student-centered*). This difference in the focus of activities has an impact on the pattern of student activities during classroom learning. There is a tendency for experimental class students to be more quick to understand the material, independent, adaptive, enthusiastic about using new media, skilled at answering written and oral questions, and all groups are seen to be active in discussions. On the other hand, control class students tend to have difficulty understanding the material, are less able to express their opinions, are passive, and lack cooperation between students. Previous research has also found differences in the achievement levels of students in experimental and control classes in disaster and environmental education that apply the SETS learning model (Fitransyah & Supardi, 2022)

The obstacles of this research are that there are students who are unable to follow the flow of the learning steps in the development and formation syntax due to a lack of ability to understand the material. This condition has an impact on the hampered development of intellectual skills in logical thinking to solve existing problems. This is evidenced by the decline in students' ability to create solutions to solve problems, students' difficulty in observing, and students' lack of understanding of how to analyze the cause and effect of a problem sequentially until a solution is found. Therefore, teachers need a special learning strategy and method to deal with this problem.

## 4. Conclusion

Based on the findings of this research, it can be concluded that the implementation of the *Science, Environment, Technology, and Society* (SETS) learning model integrated with *Google Earth* in Geography learning on Disasters and the Environment material affects students' spatial thinking ability. There are three dominant syntaxes in the SETS learning model integrated with *Google Earth* that can trigger and train spatial thinking ability, namely in the syntax of initiation, concept development and formation, and concept application. In this syntax, students are invited to investigate, analyze, and form spatial thinking concepts in a complete and structured manner. Supported by the use of *Google Earth* learning media that can help students in developing their thinking framework, because *Google Earth* can display changes in objects and provide visual phenomena on the earth's surface. The lack of attention to student's activities during the learning process makes it difficult to elaborate on the impact on each student, thus becoming a shortcoming of this article. This study has a limitation in that it solely focused on the attainment of students' spatial thinking skills without closely examining the students' learning processes and activities in the classroom. The suggestions submitted for further research are that researchers can use special learning methods in applying the SETS model integrated with *Google Earth* in the syntax of *concept formation* and *development.* Teachers can use demonstration, discussion, problem-based learning, and other methods as needed. This can be a strategy to make it easier for teachers to convey material to the students.

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