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Earthcomm Model's Influence on Spatial Thinking Capacity and Environmental Care Character Development: A Focused Study

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ABSTRACT

Geography learning can be conducted with an Earthcomm learning model covering cognitive and affective skills. Solving these environmental challenges requires geographic and environmental literacy. This research evaluates the effectiveness of the Earthcomm model in enhancing spatial thinking and environmental care for high school students in Bululawang. A quasi-experimental design with pre- and post-tests randomly assigned 72 students to experimental and control groups. Instruments used were a 10-question spatial thinking essay, a 30-question environmental care survey, and Earthcomm-based worksheets. Analysis showed significant effects of the educational intervention on spatial thinking ($p = 0.000$) and environmental care ($p = 0.023$). Thus, a statistically significant correlation exists between those variables (p= 0,000), indicating that improving spatial skills may lead to greater environmental responsibility. The N Gain Score (NGS) assessment reveals that this model, with 47.9% NGS, is "less effective" in superior improvement due to the less implementation period in the syllabus, which necessitates further utilization and modification of the syllabus to guarantee effectivity. Despite such limitations, the findings have important implications for the Earthcomm model and its potential use in geography education, particularly in promoting spatial thinking and environmental care. This adds a small but important contribution to the limited literature on innovative geography curricula, illustrating how this model can equip students to meet the challenges of current global environmental issues. However, more attention will be paid to iterating, expanding, and applying the Earthcomm model to foster these skills.

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1. INTRODUCTION

The rapid development of globalization has brought significant advancements in science and technology, offering numerous benefits to individuals. However, it has also contributed to a concerning issue: character degradation (Retta & Rahmat, 2020; Tsoraya et al., 2023). This decline in character manifests through unruly behavior, lack of responsibility, and diminished concern for the social and natural environments (Mónus, 2022). Such attitudes negatively impact an individual's character, leading to harmful actions that can cause environmental problems in their surroundings (Ismail, 2021). Addressing this issue requires a strong emphasis on character education, aimed at nurturing individuals who are not only intellectually capable but also demonstrate a deep concern for social and environmental well-being.

Education plays a crucial role in shaping individual character and enhancing cognitive abilities. One of the most critical cognitive aspects is spatial thinking, which is fundamental to understanding geography. Spatial thinking enables individuals to perceive, interpret, and analyze the relationships between spaces and objects in their environment (Castellar, 2021). For instance, implementing a school recycling program can be a practical application of spatial thinking. Students might map the locations of trash cans and identify areas requiring improved waste management. Such activities allow students to understand the interconnections between places and their environmental contexts, enabling them to analyze environmental issues and propose effective solutions.

A similar approach can be applied at SMA Negeri 1 Bululawang, Malang Regency. Students can be encouraged to develop environmental awareness and responsibility through geography education. By focusing on biotic, abiotic, and social elements, geography lessons can nurture students' capacity to care for their environment and contribute to its sustainable management (Handoyo, 2021). Integrating spatial thinking with character education supports holistic student development, fostering intellectual growth and environmental stewardship. Sensitivity to environmental issues is vital for every individual, particularly the younger generation. This generation will confront increasingly pressing environmental challenges like pollution, biodiversity loss, and climate change. The decisions and actions they take today will directly influence the state of the environment in the future. By fostering an environmentally conscious character early on, young people can develop habits and attitudes that promote sustainability. Therefore, it is essential to integrate environmental values into character education using learning models that align with educational objectives (Silvia & Tirtoni, 2023).

The Earthcomm learning model is one of the approaches that integrate the concept of spatial thinking with contextual environmental issues. This model emphasizes the learning process more than just the final outcomes (Aliman et al., 2022), enabling students to move beyond passive learning and actively construct their own understanding. The Earthcomm model fosters active student engagement through projects, discussions, and research, encouraging students to explore human-environment interactions using geospatial tools such as ArcGIS, Google Maps, and other geospatial applications (Purnomo, 2019). To evaluate the effectiveness of the Earthcomm model on spatial thinking skills, educators can assign field-based projects through structured student worksheets. These tasks allow students to apply their spatial reasoning in real-world contexts. Meanwhile, assessing the model's impact on environmental care can be achieved through questionnaires that explore beliefs about sustainability, environmentally friendly behaviors, and knowledge of environmental issues. These assessments are complemented by hands-on activities such as organizing clean-up campaigns, planting trees, and participating in conservation projects. This combination of theoretical and practical learning ensures that students develop cognitive and character-based competencies aligned with environmental education objectives.

Various learning models have been utilized to enhance students' spatial thinking skills and foster an environmental care character. For instance, the Environmental Care Character Service Learning Model emphasizes integrating service-based activities with learning to instill environmental responsibility (Kasi et al., 2018). The Contextual Approach to Shaping Environmental Education has been proposed as an effective alternative for establishing green schools by embedding environmental principles into the school culture (Wetering et al., 2022). Similarly, the Experiential Learning Model Based on Local Wisdom leverages indigenous knowledge and practices to enrich environmental learning experiences (Immaniar et al., 2019).

Field visit models also contribute significantly by promoting a natural attitude and environmentally conscious behaviors among students (Putra et al., 2021). Moreover, project-based learning, particularly through tools like Google Earth, has significantly enhanced spatial thinking skills (Isnaini et al., 2023). This approach encourages students to engage directly with their surroundings, fostering a deeper understanding of spatial and environmental concepts (Oktavianto, 2017). These models demonstrate the effectiveness of integrating hands-on, contextual, and technology-based approaches to cultivate cognitive and character-based competencies in environmental education. Based on preliminary surveys conducted by the researcher and interviews with geography teachers, it was revealed that some students still exhibit poor environmental habits, such as storing garbage in their desk lockers. Teachers teach students to clean their desk lockers in the last hour before leaving school to address this issue. Despite these efforts, and even though the school has received the prestigious Adiwiyata award for its environmental initiatives, some classrooms fail to maintain cleanliness. To encourage better habits, the school conducts regular assessments and announcements during Monday flag ceremonies, recognizing the cleanest and dirtiest classrooms to motivate students to maintain a clean environment. These practices highlight that while many students exhibit environmental care, there are still those with low levels of awareness and responsibility, indicating the need for behavioral change.

The Earthcomm learning model plays a pivotal role in addressing this issue by focusing on imparting knowledge and fostering values and attitudes toward environmental conservation. Earthcomm encourages students to internalize the importance of maintaining a clean and sustainable environment by integrating environmental themes into the learning process. Through repeated exposure to these values, students can gradually change their habits and develop a stronger environmental character. Conversely, without exposure to such relevant material, students are likelier to continue harmful behaviors, underscoring the critical need for targeted educational interventions.

Despite the widespread adoption of various learning models, the integration of the Earthcomm learning model into developing spatial thinking skills and fostering environmental awareness remains limited. This is surprising given the model's high relevance in addressing current global challenges, educational demands, and

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rapid technological advancements. The Earthcomm learning model provides an innovative approach that aligns with the need to equip students with critical spatial reasoning abilities while instilling environmental responsibility, making it an ideal tool for modern education.

This study focuses on examining the effects of the Earthcomm learning model on high school students' environmental care character and spatial thinking skills. It also seeks to explore the relationship between these two aspects, aiming to highlight their interconnection in fostering an academically proficient and environmentally conscious generation. The study offers valuable insights into enhancing geography education by investigating these dynamics, emphasizing the dual importance of cognitive and affective development to address contemporary environmental challenges. The findings provide new perspectives for integrating spatial thinking and environmental education into geography instruction, ultimately supporting sustainable development goals through education.

2. MATERIAL AND METHOD

Research Design and Participants

The research employed a quasi-experimental method and was conducted at SMAN 1 Bululawang, East Java. The study utilized a Pretest-Posttest Nonequivalent Control Group Design to evaluate the effectiveness of the Earthcomm learning model. This design allowed the researcher to assess the impact of the intervention by comparing the pretest and posttest results of the experimental and control groups.

The Earthcomm learning model was implemented in the experimental group, focusing on inquiry-based and student-centered activities to develop spatial thinking skills and environmental awareness. Meanwhile, the control group followed a traditional learning model, which included lectures, exams, debates, and assignments. The comparison of outcomes between these groups provided a clear understanding of the Earthcomm model's effectiveness in achieving the study's objectives. The research process consisted of three key stages: pretest, treatment (implementation of the learning models), and posttest. These stages are summarized in Table 1 below, outlining the sequence of activities conducted in both the experimental and control classrooms. This structured approach comprehensively evaluated the learning model's impact on students' spatial thinking and environmental care traits.

Table 1. Pretest and Posttest Research Design of Nonequitized Control Group Design

Class	Pretest	Model	Posttest
Experiment	O_1	X1	O_2
Control	O_3	X2	O_4

Description:

O1 = pretest of experimental class; O2 = experimental class posttest
O3 = control class pretest; O4 = control class posttest
X1 = using the Earthcomm model; X2 = using the Earthcomm model

The research sample was taken with the purposive sampling technique, which is a sample determination technique using certain considerations, as in the results of the initial observation, the control and experimental classes had equivalent geographical average values. This study has no differentiator, such as the initial ability level, so the comparison of learning outcomes can be done fairly. In addition, because of the character of students from both classes who are proactive in learning. This is due to the recommendation of the geography teacher and the limitation of the specified research time.

A total of 72 students became the research sample, consisting of class X 1 as the control group and class X 5 as an experimental group, with the same number of students, namely 36 students in each class. The research on the subject lasted for 4 weeks, starting from the initial observation on February 13, 2024, to April 30, 2024, in the even semester of 2023/2024, with learning materials about the environment in the Hydrosphere subchapter.

Instrument

This study involved three variables: the Earthcomm learning model **(X)** as the independent variable, spatial thinking ability **(Y1)** as the dependent variable, and environmental care character **(Y2)** as the moderator variable. These variables were measured using a 10-item essay test instrument based on spatial thinking

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indicators developed by Huynh and Sharpe (2013). These indicators include comprehension, spatial interactions, analysis, application, representation, and scale. Essay questions were chosen as the measurement instrument because they allow students to provide in-depth analytical explanations, demonstrating their understanding of and ability to relate complex geographic concepts, such as the hydrosphere and its environmental connections. This method is particularly important as deeper cognitive understanding often cannot be adequately captured through multiple-choice questions alone. Using essay questions thus ensures a more comprehensive assessment of students' spatial thinking abilities.

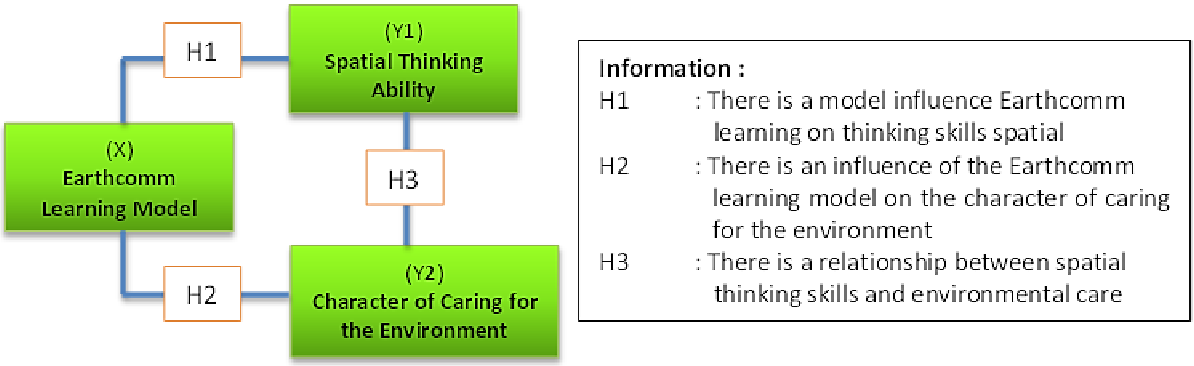

Figure 1. Hypothesis

In addition, a student worksheet (LKPD) was also used which in the assignment contained the steps of the Earthcomm learning model (Park et al., 2005), and 30 environmental care character questionnaire questions consist of three measurement components: knowledge of hydrosphere materials, character, and skills (Haul et al., 2021). Of course, all of these research instruments have been tested for the validity of question items with the Pearson Correlation test, the reliability test through the Cronbach's alpha test, the difficulty test of question items, and the test of material expert validators and education expert validators. The data acquisition results will go through the stages of analysis techniques in the form of a simple linear regression hypothesis test using SPSS 25, a normality test with Kolmogorov Smirnov, and a homogeneity test through Levene's test for equality of variances.

Implementation of the Learning Model

The original Earthcomm learning model consists of eight steps; however, this study streamlined these steps into seven main stages. This modification addressed time constraints, ensuring the learning process could be completed within time without compromising the model's core principles. The seven stages selected for this study represent the essential components of the learning process most relevant to achieving the research objectives. At the same time, the remaining steps were deemed supplementary and could be integrated as needed.

Additionally, to reinforce the character of environmental care, the researcher concluded the activity by inviting students to participate in planting greenery around the school environment. This practical initiative provided students with a tangible experience in environmental stewardship, fostering early habits and attitudes that support sustainable practices. This integration of real-world application with theoretical learning underscores the Earthcomm model's emphasis on holistic education.

The tests distributed to students are then corrected and processed using the following formula:

$$\text{Value} = \frac{\text{Number of correct question}}{\text{Number of questions}} \text{X } 100$$

After collecting the research data, prerequisite tests were conducted, including Levene's test for equality of variances to assess homogeneity and the Kolmogorov-Smirnov test to evaluate normality. Once the

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prerequisite tests confirmed that the data were normal and homogeneous, the analysis proceeded with simple linear regression. This method was used to test the hypothesis and determine how the independent variable (Earthcomm learning model) influenced the dependent (spatial thinking skills) and moderator (environmental care character) variables.

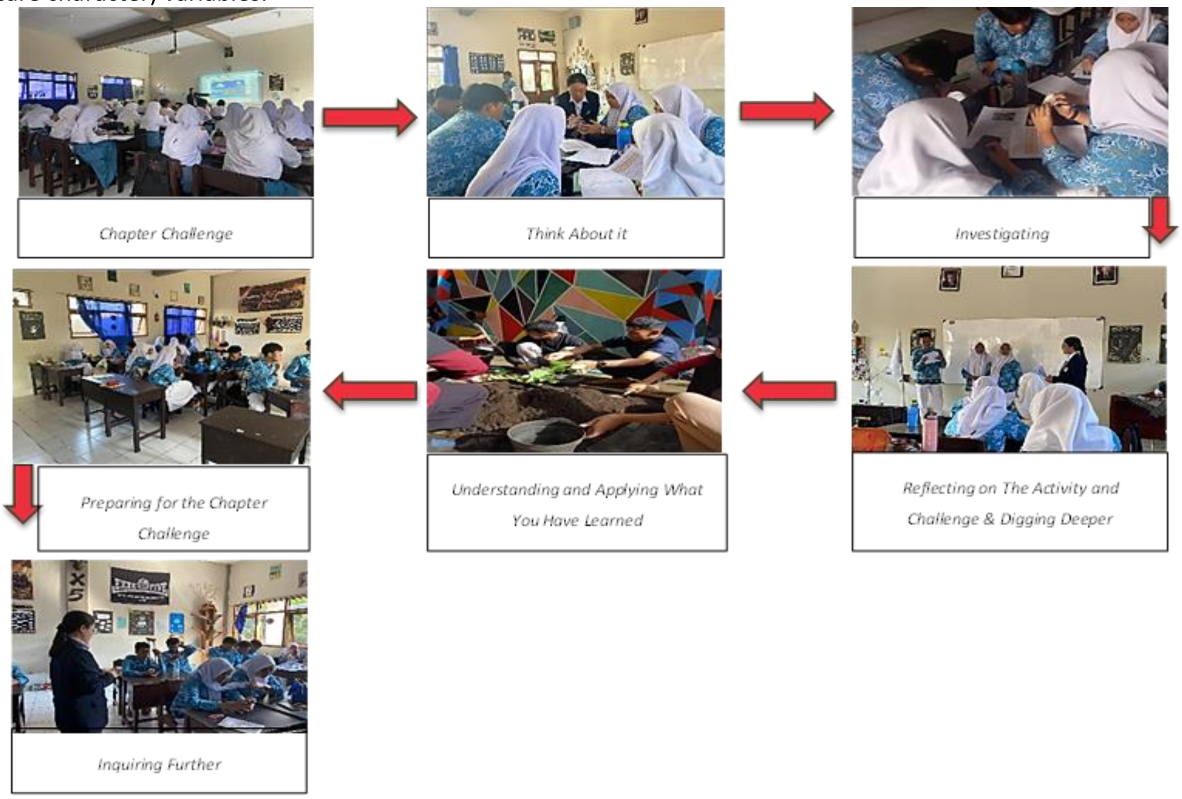

Figure 2. Syntax of Earthcomm Learning Model

A simple correlation analysis was also performed to evaluate the relationship between the moderator variable (environmental care character) and the dependent variable (spatial thinking skills). Finally, the N Gain Score test was employed to measure the effectiveness of the Earthcomm learning model in enhancing high school students' spatial thinking skills. These statistical methods provided comprehensive insights into the impact and efficacy of the Earthcomm learning model within the study's context.

3. RESULT

The normality and homogeneity tests resulting from the data prerequisite tests are shown below, conducted with SPSS 25 Windows.

Table 2. Normality Test

	Research Class	**Kolmogorov-Smirnov^a**			**Shapiro-Wilk**		
		Statistic	df	Sig.	Statistic	df	Sig.
Result in Environmental Awareness	Pretest Control	0,135	34	.122	.960	34	.239
	Posttest Control	0,096	34	.200*	.972	34	.507
	Pretest Experiment	0.119	33	.200*	.969	33	.446
	Posttest Experiment	0.124	33	.200*	.967	33	.404

Table 3. Homogeneity Test

Levene Statistic	**df1**	**df2**	**Sig.**
1.778	3	130	0.155

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The normality test aims to determine whether the data in a sample follows a normal distribution, using a significance level of 0.05. The analysis used the Kolmogorov-Smirnov statistical test in SPSS 25 for Windows. As shown in Table 2, the results indicate that the data is normally distributed (Sig > 0.05). Similarly, based on the Levene test results presented in Table 3, the homogeneity test confirmed that the data is homogeneous (0.155 > 0.05). With these prerequisites met, the analysis can proceed to hypothesis testing, employing a simple linear regression test, as shown in Table 4, by the required test criteria.

Table 4. Simple Linear Regression Test

Model		Sum of Squares	df	Mean Square	F	Sig.
* X Y1	Regression	1983.442	1	1983.442	20.510	0.000[b]
** X Y2	Regression	524.520	1	524.520	5.383	0.023[b]

Table 4's Model XY1 column data indicates that the Earthcomm learning model significantly impacts spatial thinking skills, with a significance level of 0.000 < 0.05 and an F value of 20.510. Additionally, the Earthcomm model influences environmental care, as evidenced by the Model XY2 column, which shows an F value of 5.383 and a significance level of 0.023 < 0.05. This study also evaluates the relationship between the independent and dependent variables. The statistical analysis results regarding the degree of correlation between these variables are presented below.

Table 5. Variable R Square Test

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.490[a]	0.240	0.228	9.834
2	0.277[a]	0.076	0.062	9.872

Table 5 presents the extent to which the Earthcomm learning model influences spatial thinking skills and environmental care. The analysis shows that the Earthcomm model has a 24% effect on spatial thinking skills, as indicated by a coefficient of determination (R Square) of 0.240 and a relationship value (R) of 0.490. For environmental care, the Model 2 column reports an R-value of 0.277 and an R Square of 0.062, indicating that the Earthcomm model accounts for 7.6% of the variance in the environmental care character.

Table 6. Pearson Correlation Test

Correlations			
		Spatial Thinking Ability	Character of Caring for the Environment
Spatial Thinking Ability	Pearson Correlation	1	0.486**
	Sig. (2-tailed)		0.000
	N	67	67
Character of Caring for the Environment	Pearson Correlation	0.486**	1
	Sig. (2-tailed)	0.000	
	N	67	67

Table 6 demonstrates a positive correlation between environmental concern and spatial thinking skills. The 2-tailed Sig value of 0.000 < 0.05 confirms the statistical significance of this relationship, with a Pearson correlation coefficient of 0.486. This indicates a moderate positive connection, suggesting that improving high school students' spatial thinking skills positively influences their environmental awareness and concern.

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Spatial Thinking Ability

The average results of the pretest and posttest scores administered to students in the experimental and control classes are shown below.

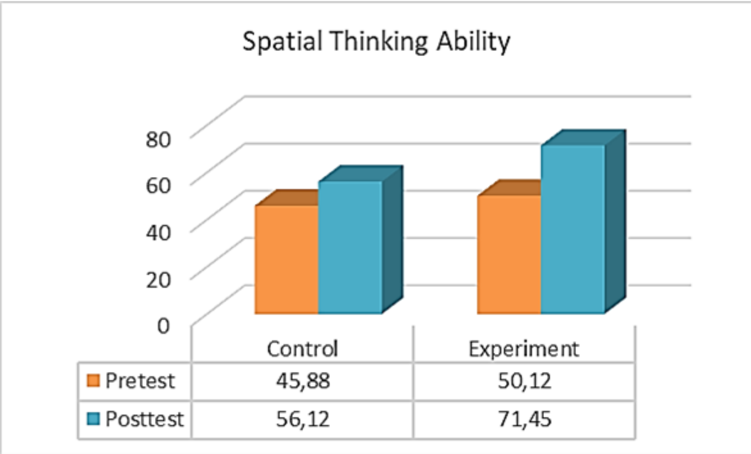

Figure 3. Average Pretest Posttest Score of Research Class

Based on Figure 3, the control group had an average pretest score for spatial thinking ability of 45.88, while the experimental group scored slightly higher, with an average pretest score of 50.12. The initial difference between the two groups was minimal, at only 4.24 points. After the posttest, the average spatial thinking ability in the control group increased to 56.12, while the experimental group achieved a significantly higher average of 71.45. This posttest result shows a notable difference of 15.33 points between the two groups, highlighting the greater improvement in the experimental group.

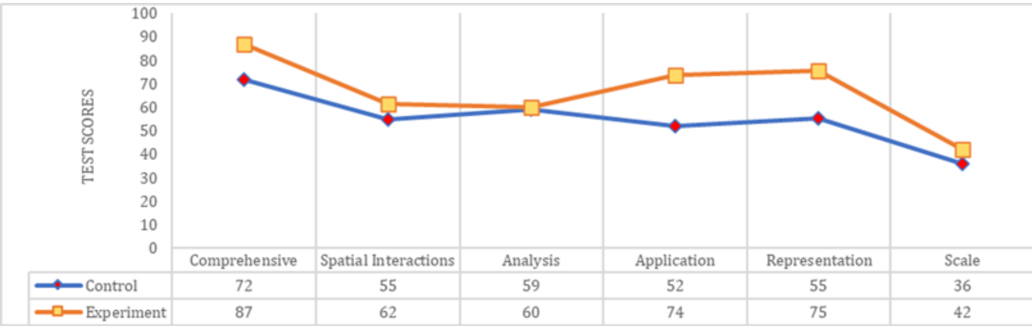

Figure 4. Average Score of Spatial Thinking Ability for Each Indicator

As illustrated in Figure 4, the spatial thinking ability test yielded the lowest average scores, with the control group scoring 36 and the experimental group scoring 42. Low spatial thinking skills may result from a lack of experience or practice in tasks that require spatial reasoning. While individuals may possess theoretical knowledge, they may struggle to apply it effectively in real-life scenarios (Memmase & Purwanto, 2024). For instance, understanding that distances on a map must be measured and calculated using a specific scale to determine actual distances in the real world exemplifies the gap between knowledge and practical application.

Character of Caring for the Environment

In Figure 5, the experimental class achieved an average score of 85, surpassing the control class's score of 74. These scores were based on the environmental care character components of knowledge, character, and skills. The experimental class showed the highest improvement in the knowledge component, with an average

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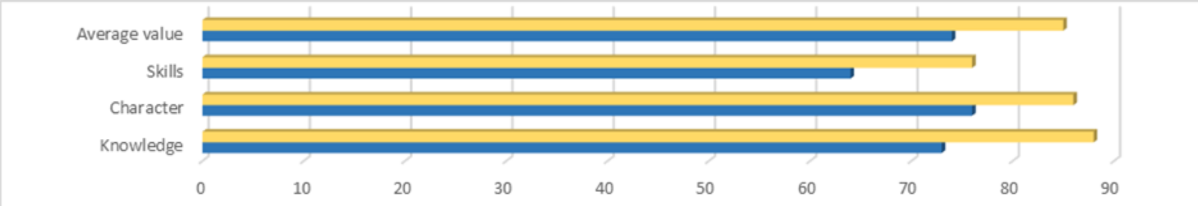
score of 88 compared to the control class's 73. However, the skill component scores were lower, with the experimental class scoring 76 and the control class 64. This disparity suggests that while environmental knowledge may increase, its application in daily life can be hindered by factors such as a lack of awareness or self-reflection. As Afifah et al. (2024) noted, understanding environmental management does not always translate into behavior change without sufficient personal awareness or reflection.



	Knowledge	Character	Skills	Average value
Experiment	88	86	76	85
Control	73	76	64	74

Figure 5. Average Score of Results of Filling Out the Environmental Care Character Questionnaire for Each Indicator Score of Spatial Thinking Ability for Each

Table 7. Test N Gain Score

Class		Statistic
Experiment	Mean	47.9455
	Minimum	28.57
	Maximum	73.08
Control	Mean	19.0084
	Minimum	3.85
	Maximum	32.00

Table 7 shows the N-Gain scores, where classrooms using the Earthcomm learning model achieved an average N-Gain of 47.9%, categorized as less effective, with a range of 28.57% to 73.08%. In contrast, traditional learning models had an average N-Gain of 19%, classified as ineffective, with a range of 3.85% to 32%. The gradual development of spatial thinking skills may result in low N-Gain scores, as improvements may not be immediately apparent in pretest and posttest results.

The research indicates that the Earthcomm learning model is ineffective for developing spatial thinking skills in grade X students at SMAN 1 Bululawang for Hydrosphere content. Similarly, traditional learning models also fail to support this material's development of spatial thinking skills. The ineffectiveness of the Earthcomm model is attributed to limited implementation time, as the model requires multiple stages and a longer duration, making it applicable only to specific lessons (Dia et al., 2021). Additionally, the Earthcomm learning model has limitations in significantly improving spatial thinking skills, as reflected in the N-Gain scores. Factors such as varying student ability levels and a lack of practice may also contribute to the suboptimal results (Hickman, 2022).

4. Discussion

The Effect of the Earthcomm Model on Spatial Thinking Ability

In Earthcomm learning, students engage in classroom and outdoor activities, providing a unique learning experience (Memmase & Purwanto, 2024). One notable benefit of this model is its outdoor component, where students conduct direct field investigations during the "Investigate" stage (Nisa et al., 2021). These investigations help students gain a deeper understanding of their environment, further explored in the "Think About It" stage,

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enriching their learning through real-world experiences. Students develop spatial sensitivity by observing and interacting with real conditions, reinforced during the "Check Your Understanding and Applying What You Have Learned" stage. This hands-on process allows students to apply their ideas and address problems encountered during investigations, significantly enhancing their spatial thinking skills, particularly in their posttest performance.

Earthcomm learning activities that engage students in implementing their ideas in the field have been shown to enhance spatial thinking skills (Mutaqin, 2021). As illustrated in Figure 4, the experimental class achieved the highest average score of 87, compared to 72 in the control class, on comprehensive indicators. These indicators assess students' ability to understand spatial relationships, orientation, and perspective holistically. Such development occurs naturally as students frequently apply spatial understanding in everyday activities, such as interpreting orientations at school or home, arranging objects, and reading simple maps (Sumarmi et al., 2023). These daily experiences foster a comprehensive understanding of spatial relationships, contributing to the improvement of spatial thinking skills.

These findings are reinforced by additional research, which shows that Earthcomm learning can effectively improve the spatial thinking abilities of high school students in Malang City (Aliman et al., 2024). Earthcomm learning closely aligns with experiential learning in the field and within the community, making it well-suited to developing spatial thinking skills. By integrating hands-on, real-world experiences, Earthcomm learning provides an effective framework for enhancing students' spatial reasoning and problem-solving abilities.

The Influence of the Earthcomm Model on the Character of Caring for the Environment

The simple linear regression test results in Table 4 indicate that the Earthcomm learning model effectively fosters students' respect for the environment. This study found a positive correlation between the increased environmental consciousness of grade ten students and the implementation of the Earthcomm model. The Earthcomm model engages students directly in activities addressing environmental issues by utilizing an interactive and project-based approach. This hands-on involvement is essential, as environmental consciousness requires more than theoretical knowledge; students need firsthand experiences to understand how their actions impact the environment (Hickman, 2022).

Environmental consciousness is rooted in a proactive approach to protecting and maintaining the environment. The Earthcomm model facilitates this by allowing students to analyze and address real-world environmental challenges through group discussions, field projects, and case studies. This hands-on approach enables students to identify problems and develop practical solutions, fostering an attitude toward environmental care and its direct application. These findings align with previous research highlighting the positive impact of contextual and active learning strategies, such as those employed in the Earthcomm model, on character development (Dia et al., 2021). Active participation in the learning process increases students' awareness and concern for environmental issues, demonstrating the Earthcomm model's effectiveness as a tool for environmental education.

The Relationship Between Spatial Thinking Ability and Environmental Care Character

This study reveals a relationship between the dependent and moderator variables, highlighting the Earthcomm learning model's role in fostering environmental character through a spatial thinking approach. By helping students understand the real impact of human actions on their surroundings, the Earthcomm paradigm promotes environmentally conscious behavior (Aliman et al., 2019; Dia et al., 2021). Students engage in environment-based projects addressing issues like water conservation or ecosystem rehabilitation (Nisa et al., 2021), working in teams to plan and implement community-driven solutions. Examples include mapping flood-prone areas and designing improved drainage systems, encouraging students to take direct responsibility for environmental conservation, enhancing their awareness and commitment.

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However, environmentally conscious behaviors often demand extra effort and may conflict with the convenience and comfort many prioritize. While individuals may understand sustainability concepts, they often struggle to adopt eco-friendly habits, such as reducing waste or utilizing renewable energy, due to a lack of practical guidance or starting points (Afifah et al., 2024; Masruroh, 2019). This underscores the importance of models like Earthcomm in equipping students with the skills and motivation needed to implement sustainable practices effectively.

5. CONCLUSION

The findings highlight the effectiveness of the Earthcomm learning model in enhancing spatial thinking skills. Post-test results from the experimental group demonstrated significant improvements in scores, reflecting a better understanding and positive attitudes toward environmental conservation. Activities like tree planting and maintaining cleanliness contributed to this progress, with high post-test scores indicating meaningful development. These results emphasize the value of Earthcomm as an innovative learning strategy for geography teachers, enabling the integration of geospatial tools such as ArcGIS into lessons. Schools can also apply this model to broader initiatives, such as collaborative projects that address local environmental issues. Practical activities like green area mapping or water and air quality monitoring allow students to apply spatial thinking skills in real-world contexts, increasing their awareness of environmental challenges. This study is equally valuable for future research, providing a foundation for further exploration of the connections between learning models, spatial thinking skills, and students' environmental character development. It also serves as a reference for similar studies across different cognitive levels. Effective geography education requires learning models that go beyond cognitive outcomes, offering meaningful, process-oriented learning experiences. The Earthcomm model aligns with this need, focusing on active engagement through observation, inquiry, data analysis, and problem-solving. Such an approach fosters cognitive growth and cultivates practical skills and environmental awareness, making it a comprehensive educational strategy.

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