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DEVELOPMENT OF A GREEN EDUCATION-BASED HORTICULTURE LEARNING MODEL TO IMPROVE STUDENTS' ENVIRONMENTAL AWARENESS

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Abstract. This study aims to develop a green education-based horticulture learning model to increase environmental awareness of students is the Biology Education Study Program at STKIP Arrahmaniyah Depok. The study used the Research and Development (R&D) method through the stages of development, expert validation, and learning trials. Data were obtained through expert validation, learning outcome tests, student participation observations, and environmental awareness measurements. The results showed that the developed learning model was effective in increasing students' environmental awareness. The level of environmental awareness increased from 55.6 to 77.8 after the implementation of the learning model. The average value of student learning outcomes also increased from 73.33 in the pretest to 80.00 in the posttest. The results of the material expert validation obtained a percentage of 82% with a good category, while the validation of the learning model expert obtained a percentage of 92% with a very good category, so the model was declared suitable for use. The effectiveness of the model was also seen from the increase in the average score of students in Trial I of 60.55 to 89.92 in Trial II. The gain index analysis of 0.73 is included in the high category. In addition, active student participation increased from 71 to 77 during the learning process.

Keywords: Green education, horticulture learning model, environmental awarness

I. INTRODUCTION

Environmental issues are becoming increasingly complex global issues, driven by increasing ecosystem destruction, climate change, environmental pollution, and the uncontrolled exploitation of natural resources. These conditions demonstrate that development that ignores the principles of sustainability has had a serious impact on environmental balance and human quality of life. Issues such as increasing carbon emissions, reduced green space, water and air pollution, and declining biodiversity are challenges facing the global community today. Therefore, strategic efforts are needed to raise public awareness of the importance of preserving the environment through various sectors, including education.[1]

Education plays a strategic role in developing public awareness, knowledge, and behavior, fostering greater concern for environmental sustainability. Education serves not only as a process of knowledge transfer but also as a means of developing students' ecological character and social responsibility towards the environment. In this context, the concept of green education, or environment-based education, is a relevant approach to be implemented in the learning process. Green education is an educational approach that emphasizes the integration of sustainability values, environmental conservation, and the development of environmentally friendly behaviors in learning activities.[2]

Environmental education plays a crucial role in shaping environmentally conscious and responsible behavior in society. Through education, students not only gain a conceptual understanding of the environment but also develop attitudes, values, and skills for maintaining environmental sustainability. Sri Rahayu Pudjiastuti explains that environmental education needs to be implemented through concrete and participatory activities to build students' ecological awareness sustainably. Environmental-based education programs, such as eco-pesantren (Islamic boarding schools), have been shown to increase students' understanding and awareness of environmental sanitation and waste management.[3]

Furthermore, Pudjiastuti explains that environmental damage is fundamentally caused by development patterns that ignore environmental balance, leading to ongoing environmental pollution and degradation.[4] Therefore, environmental education needs to be directed at fostering ecological awareness through contextual and applicable learning. Strengthening environmental education can also be achieved through the formation of ecological citizenship based on a green constitution integrated into the education system, thereby increasing community and student participation in preserving the environment.[5]

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Research by Pudjiastuti et al. on the culture and local wisdom of the Kasepuhan Sinar Resmi indigenous community shows that local values that maintain the balance of nature can be used as a learning resource to build students' ecological awareness.[6] Furthermore, other research indicates that clean and healthy living behaviors and environmental awareness can be improved through learning that involves students' active participation in direct environmental activities.[7] This demonstrates that participatory, experiential environmental education has a significant influence on the development of environmentally conscious behavior. In the context of higher education, the Biology Education Study Program plays a crucial role in preparing prospective educators who not only understand biological concepts scientifically but also possess a strong ecological awareness. However, the biology learning process in higher education still tends to be oriented towards mastering theoretical concepts and does not fully provide contextual experiences capable of shaping students' environmentally conscious behavior. Students often understand environmental concepts only cognitively but are unable to implement ecological values in their daily lives. This condition indicates the need for innovative learning models that are able to integrate biological knowledge with real experiences in environmental management.[8]

One relevant approach to addressing these challenges is the development of a green education-based horticulture learning model. Horticulture learning is strongly relevant to the green education approach because it provides students with the opportunity to learn directly through practical experiences in plant cultivation, environmental management, and sustainable use of natural resources. Horticulture activities not only help students understand the concepts of plant growth and development but also instill the values of responsibility, environmental stewardship, and ecological skills through real-world experiences. Research by Lozano et al. shows that sustainability-based learning in higher education significantly increases students' environmental awareness, systemic thinking skills, and social responsibility.[9]

The development of a green education-based horticulture learning model is also supported by the experiential learning theory proposed by Kolb.[10] This theory explains that learning will be more effective when students gain direct experience in the learning process. Through concrete experiences, reflection, conceptualization, and active practice, students are able to build a deeper and more contextual understanding. In horticulture learning, students not only receive theoretical explanations about plants and the environment but also actively engage in the practice of planting, caring for, and managing plants. This experience enables students to understand the relationship between humans and the environment in a concrete way, thereby fostering a stronger ecological awareness.

In addition to experiential learning theory, a constructivist approach is also an important foundation in the development of this learning model. Constructivist theory positions students as active subjects who construct knowledge through interactions with the environment and the learning experiences they acquire. Practice-based horticultural learning allows students to independently observe, explore, and solve problems, making the learning process more meaningful and contextual. Research by Salehudin et al. shows that a constructivist approach to environmental learning can significantly improve students' critical thinking skills and ecological awareness.[11]

From an environmental awareness perspective, environment-based learning has a significant influence on developing students' environmental awareness. Environmental awareness is an individual's ability to understand environmental conditions, recognize the impact of human activities on ecosystems, and demonstrate behaviors that support environmental preservation. Individuals with high environmental awareness tend to be more active in maintaining a clean environment, conserving resources, and supporting conservation activities.[12] Therefore, green education-based horticulture learning is a relevant strategy for increasing environmental awareness in Biology Education students through hands-on experience in environmental management.

The development of the Sustainable Development Goals (SDGs) issue also further emphasizes the importance of integrating environmental education into the higher education system. Universities are not only required to produce academically competent graduates but also individuals with social awareness and ecological responsibility for environmental sustainability. In this context, developing a green education-based horticulture learning model is crucial as an effort to create a contextual, participatory learning process that is oriented toward building students' ecological character.

Various previous studies have shown that environment-based learning has a positive influence on improving students' ecological knowledge, environmental awareness, and critical thinking skills. Research by Suryawati et al. demonstrated that environment-based biology learning can improve students' environmental literacy through contextual and experiential learning activities.[13] Furthermore, research by Prasetyo and Suyanto explains that implementing green learning in science can shape students' pro-environmental behavior through the integration of sustainability issues into the learning process.[14]

However, most previous research has focused on the implementation of environmental education in general and has not specifically developed a green education-based horticulture learning model in the Biology Education Study Program. Previous research tends to position horticulture solely as a medium for plant cultivation practicums without systematically integrating aspects of sustainability, ecological awareness, and the development of students' environmental character into their learning design. Furthermore, research on horticulture learning in higher education generally focuses on improving cognitive learning outcomes and technical cultivation skills, while students' environmental awareness has not received much in-depth study.[15]

Furthermore, the evolving issue of Education for Sustainable Development (ESD) demands innovative learning models that emphasize not only mastery of academic concepts but also the development of ecological awareness

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and sustainable behavior in students. Research by Kurniawan et al. shows that environmental project-based learning has significant potential in increasing student awareness of environmental issues, yet its implementation has not been optimally integrated into horticulture-based biology learning. [16] This indicates a research gap regarding the development of a horticulture learning model specifically designed based on green education to increase environmental awareness in Biology Education students.

Based on this description, the novelty of this research lies in the development of a green education-based horticulture learning model that integrates the principles of environmental sustainability, experiential learning, and a constructivist approach into biology instruction in higher education. This research focuses not only on improving students' cognitive learning outcomes but also on fostering environmental awareness, ecological behavior, and sustainability responsibility in Biology Education students. Furthermore, this research offers a more contextual and applicable horticulture learning design through active student involvement in direct environmental management practices.

Thus, this research aims to develop a green education-based horticulture learning model to increase environmental awareness among Biology Education students. The developed learning model is expected to be a pedagogical innovation that not only enhances understanding of biological concepts but also fosters environmental awareness and sustainability awareness in students' daily lives.

II. RESEARCH METHODS

This study employed a Research and Development (R&D) approach, aiming to develop a green education-based horticulture learning model to increase students' environmental awareness. The R&D approach was chosen because the research focuses not only on testing theory but also on producing educational products in the form of learning models that can be applied in lectures. According to Sugiyono, research and development is a method used to produce specific products and test their effectiveness.[17] The development model used in this study is the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation.

The first stage is analysis. This stage identifies horticulture learning needs and analyzes the learning conditions currently underway for students in the Biology Education Undergraduate Program at STKIP Arrahmaniyah. The analysis aims to determine the extent of environmental education implementation in horticulture courses and the level of students' environmental awareness. Activities at this stage include observing the learning process, interviewing the lecturers, and distributing student needs questionnaires. The analysis stage is crucial to ensure the learning model developed aligns with student characteristics and learning needs.[18]

The second stage is design. At this stage, researchers designed a green education-based horticulture learning model, which included developing learning objectives, learning steps, learning media, learning tools, and research instruments. The green education concept was integrated into learning activities through horticultural practices oriented toward environmental conservation, wise resource utilization, organic waste management, and fostering an environmentally conscious attitude. The model design was conducted with active and contextual learning principles in mind, enabling students to understand the relationship between horticulture and environmental sustainability.

The third stage is development. At this stage, the product is developed in the form of a learning model and its supporting tools. The developed product is then validated by material experts, education experts, and media experts to determine the model's feasibility. Validation is carried out on aspects of content, language, presentation, and the suitability of the green education concept. Input and suggestions from the validators are used as the basis for product revisions to make the resulting learning model more effective and suitable for use in the learning process. According to Borg and Gall, expert validation is a crucial stage in development research to ensure product quality before it is implemented for users.[19]

The next stage is implementation. In this stage, the green education-based horticulture learning model is applied to undergraduate Biology Education students taking horticulture courses at STKIP Arrahmaniyah. Research respondents were selected using a purposive sampling technique, namely students actively attending horticulture lectures during the research semester. Implementation was carried out through a limited trial using a one-group pretest-posttest design. In this design, students were given a pretest before implementing the learning model and a posttest after the learning process. This design was used to determine the increase in students' environmental awareness after participating in green education-based learning.

Data collection techniques in this study included observation, questionnaires, interviews, and documentation. Observations were used to observe student activities and the implementation of the learning model during the learning process. The questionnaire was used to measure students' levels of environmental awareness and their responses to the implemented learning model. The questionnaire instrument used a Likert scale with indicators covering environmental concern, environmentally friendly behavior, environmental responsibility, and plant and organic waste management skills. Interviews were conducted with lecturers and several students to obtain supporting data regarding the effectiveness of the learning model. Documentation was used to supplement the research data in the form of photos of activities, learning materials, and student work.

The final stage is evaluation. Evaluation is conducted both formatively and summatively. Formative evaluation is conducted at each stage of development to address deficiencies in the learning model, while summative evaluation is conducted to determine the model's effectiveness in increasing students' environmental awareness. Qualitative data obtained through observation and interviews are analyzed descriptively, while quantitative data are analyzed using percentages, average scores, and the N-Gain test to determine improvements in outcomes before and after treatment. According to Hake, the N-Gain test is used to

determine the level of effectiveness of a learning process by comparing pretest and posttest scores.[20]

The results of the analysis are then categorized into three categories: high, medium, and low. The research is considered successful if the learning model is deemed feasible by the validator, there is an increase in students' environmental awareness, and students respond positively to the implementation of the green education-based horticulture learning model.

III. RESULTS AND DISCUSSION

Research on the Development of a Green Education-Based Horticulture Learning Model to Increase Environmental Awareness in Biology Education Students at STKIP Arrahmaniyah Depok has shown positive results in increasing students' environmental awareness. Based on research data, the implementation of a green education-based horticulture learning model has been proven to improve students' understanding and awareness of the environment.

The results showed that students' environmental awareness level before the implementation of the green education-based horticulture learning model was 55.6, then increased to 77.8 after the implementation of the learning model. Furthermore, there was an increase in the average student learning score, from 73.33 in the pretest to 80.00 in the posttest. These data indicate a difference in average learning scores between before and after the implementation of the learning model. Therefore, it can be concluded that the implementation of the green education-based horticulture learning model is effective in increasing students' environmental awareness.

Table 1. Increasing Students' Environmental Awareness

No	Research Indicators	Before Implementation	After Implementation	Improvement
1	Level of Environmental Awareness of Students	55,6	77,8	22,2
2	Average Pretest and Posttest Scores	73,33	80,00	6,67

Based on the data in Table 1, it is clear that students' environmental awareness increased after the implementation of the green education-based horticulture learning model. Prior to the implementation of the learning model, students' environmental awareness was at 55.6. After the implementation of the learning model, this score increased to 77.8, a 22.2% increase.

Furthermore, student learning outcomes also showed improvement. The average pretest score before the implementation of the learning model was 73.33, while the average posttest score after the implementation of the model increased to 80.00. This 6.67% increase indicates that the green education-based horticulture learning model was able to improve students' understanding and foster greater environmental awareness.

The feasibility of the developed learning model was also validated by competent experts in their fields, including material experts, learning model experts, and linguists. The validation results showed that the material quality achieved a "good" rating of 82%. Meanwhile, the learning model quality achieved a "very good" rating of 92%. These results indicate that the developed learning model is suitable for use in the learning process.

Table 2. Results of Validation of the Feasibility of the Learning Model

No	Rated aspect	Percentage (%)	Category
1	Subject Matter Expert Validation	82%	Good
2	Expert Validation of Learning Models	92%	Very Good

Based on the data in Table 2, the results of the validation of the learning model's feasibility indicate that the green education-based horticulture learning model is considered suitable for use. The assessment by the material experts yielded a score of 82%, categorized as "good." This result indicates that the material structured in the learning model aligns with the learning objectives and student needs.

Meanwhile, the validation results from the learning model experts yielded a score of 92%, categorized as "very good." This indicates that the developed learning model possesses excellent quality in terms of presentation, learning steps, and the application of the green education approach. Therefore, the developed learning model is deemed suitable for implementation in the learning process.

Furthermore, the effectiveness of the learning model was also evident from the results of the two-stage trial. In Trial I, the average student score reached 60.55, while in Trial II, it increased to 89.92.

Table 3. Results of the Learning Model Trial

No	Trial Phase	Average value	Information
1	Trial I	60,55	Before maximum increase
2	Trial II	89,92	After optimal implementation of the model

Based on the data in Table 3, the results of the learning model trial indicate an improvement in student learning outcomes. In Trial I, the average student score was 60.55. This score then increased to 89.92 in Trial II. This increase in average scores indicates that the green education-based horticulture learning model can increase the effectiveness of the learning process. Furthermore, these results also indicate that students more easily understood the learning material after implementing the developed learning model. Based on the gain index analysis, the score was 0.73, which is considered high. This indicates a significant improvement in learning outcomes after implementing the green education-based horticulture learning model.

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Table 4. Gain Index Analysis Results

No	Assessment Aspects	Gain Value	Category
1	Improving Learning Outcomes	0,73	Tall

Based on the data in Table 4, the gain index analysis yielded a score of 0.73, categorized as high. This score indicates a significant improvement in learning outcomes after implementing the green education-based horticulture learning model. A high gain index indicates that the developed learning model is effective in improving students' environmental skills and awareness. Therefore, this learning model can be used as an alternative learning method capable of improving the quality of student learning.

Active student participation during the learning process also increased. At the beginning of the lesson, active student participation was at 71, then increased to 77 in the following meeting. This increase indicates that the developed learning model is able to attract students' attention, increase active engagement in learning, and help students understand the material presented.

Table 5. Increasing Student Active Participation

No	Meeting	Active Participation Value	Improvement
1	Initial Meeting	71	-
2	Next Meeting	77	6

Based on the data in Table 5, student active participation increased throughout the learning process. At the initial meeting, the student active participation score was 71. Subsequently, at the next meeting, it increased to 77, a 6-point increase. This increase in active participation indicates that the green education-based horticulture learning model was able to capture student attention and increase student engagement in the learning process. Furthermore, students became more active in discussions, asking questions, and participating in learning activities related to environmental awareness.

Overall, the results of this study demonstrate that the green education-based horticulture learning model is effective, feasible, and capable of increasing environmental awareness among students in the Biology Education Study Program at STKIP Arrahmaniyah Depok.

The research results show that the implementation of a green education-based horticulture learning model can increase environmental awareness among students in the Biology Education Study Program at STKIP Arrahmaniyah Depok. This improvement is evident in the students' environmental awareness scores, which increased from 55.6 to 77.8 after the learning model was implemented. Furthermore, the average pretest and posttest scores also increased from 73.33 to 80.00. These data demonstrate that the green education-based learning model is effective in developing students' understanding of the importance of environmental protection through contextual and applicable learning experiences.

This increase in students' environmental awareness occurs because the green education-based horticulture learning model provides hands-on learning experiences through practical activities and environmental management. Learning involving real-life activities has been shown to increase student engagement in understanding environmental issues and foster environmentally conscious behavior. This aligns with research showing that a green education approach can improve environmental awareness, critical thinking skills, and active student participation in maintaining environmental sustainability.[21]

The horticulture learning model also provides students with opportunities for active learning through observation, planting practices, plant management, and utilizing the surrounding environment as a learning resource. These activities help students understand environmental concepts more concretely, thereby increasing their environmental awareness. Other research indicates that environment-based learning can create meaningful learning experiences and enhance students' ability to connect theory to real-world conditions.[22]

Expert validation results indicate that the developed learning model has a high level of feasibility. The material expert validation rate was 82%, categorized as good, while the learning model expert validation rate was 92%, categorized as very good. These results indicate that the learning model meets the feasibility aspects of content, language, presentation, and learning systematics. The feasibility of a learning model is crucial because it indicates that the learning tools can be used effectively in the teaching and learning process. Research by Prasetyo et al. states that expert validation is a crucial stage in learning model development to ensure the suitability of the material and the effectiveness of classroom implementation.[23]

The effectiveness of the learning model was also evident from the trial results, which showed an increase in students' average score from 60.55 in Trial I to 89.92 in Trial II. Furthermore, the gain index analysis result of 0.73 is considered high. This value indicates that the green education-based horticulture learning model can significantly improve student learning outcomes. A high gain index indicates that students experienced increased understanding after participating in the learning process using the developed model. These results align with research by Wulandari et al. stated that the environment-based learning model has a positive influence on improving students' learning outcomes and ecological awareness. [24]

The increase in active student participation from 71 to 77 also indicates that the learning model is able to create a more engaging and interactive learning environment. Students become more active in discussions, ask questions, and engage in learning activities. Active student engagement in learning is one indicator of the success of implementing a green education-based learning model. According to research by Hidayati and Nugroho, learning that involves active student

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participation can increase learning motivation, creativity, and concern for the surrounding environment.[25]

Based on the overall research results, it can be concluded that the green education-based horticulture learning model is effective in increasing students' environmental awareness. This learning model not only improves student learning outcomes but also fosters environmental awareness through active, contextual, and sustainability-oriented learning experiences.

IV. CONCLUSIONS

Based on the results of research on the development of a green education-based horticulture learning model to increase environmental awareness among students in the Biology Education Study Program at STKIP Arrahmaniyah Depok, it can be concluded that the developed learning model has proven effective in increasing students' environmental awareness. This is demonstrated by an increase in students' environmental awareness levels from 55.6 to 77.8 after the learning model was implemented. Furthermore, the average student learning outcome score also increased from 73.33 in the pretest to 80.00 in the posttest. Expert validation results indicate that the developed learning model is suitable for use in the learning process. Validation by material experts resulted in a score of 82%, categorized as good, while validation by learning model experts resulted in a score of 92%, categorized as very good. These results indicate that the learning model meets the appropriateness of content, presentation, and learning systematics. The effectiveness of the learning model is also evident in the trial results, which show an increase in students' average score from 60.55 in Trial I to 89.92 in Trial II. The gain index analysis result of 0.73 is considered high, indicating a significant improvement in learning outcomes. Furthermore, active student participation also increased from 71 to 77 during the learning process. Therefore, the green education-based horticulture learning model can be used as an effective alternative learning model to improve environmental awareness, learning outcomes, and active student participation in the learning process.

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