

## EDUCATION MODELS THAT SUPPORT SUSTAINABLE DEVELOPMENT THROUGH GREEN TECHNOLOGY

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**Abstract:**The purpose of this study is to discuss Educational Models That Support Sustainable Development Through Green Technology, the method used to conduct this study is Library Research, The results of this study are: Development of student skills in green technology innovation, collaboration between education and the technology industry, and green technology-based curriculum are closely related to creating a holistic education system that is ready to face future environmental challenges. These three aspects emphasize that the integration of education with green technology practices not only prepares students to contribute to the environmental sector, but also drives the advancement of innovation and sustainability solutions. A project-based approach, industry engagement, and continuous curriculum updates will equip students with relevant skills and knowledge. With strong collaboration and flexible curriculum, this education model creates a generation that is not only expert in green technology but also has a high environmental awareness, ready to lead in this sector and advance sustainability in the future.

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### INTRODUCTION

Sustainable development has become an urgent global agenda, where all sectors are expected to contribute to its realization, including the education sector. Amidst environmental issues that increasingly dominate global discourse, education plays a crucial role in shaping people's awareness and behavior towards sustainability. One approach that is increasingly popular is the integration of green technology in education, which not only contributes to the achievement of sustainable development, but also equips the younger generation with relevant knowledge and skills to face future environmental challenges.

Educational models that support sustainable development through green technology must be designed with sustainability principles in mind. This means that the curriculum and teaching methods must integrate environmental and sustainability concepts holistically. According to Mulyadi (2020), an educational model that is successful in adopting green technology is one that is able to create a learning environment that encourages students to think critically about environmental issues, as well as apply green technology in everyday life.

This approach can be implemented through various educational models, one of which is the project-based learning model. In this model, students are encouraged to work on projects related to green technology, such as the development of renewable energy systems, waste management, or the design of environmentally friendly buildings. Thus, students not only learn about theory, but also apply their knowledge in real contexts, which is very important for deep understanding and practical application in the real world.

Another effective model is community-based education, where educational institutions work with local communities to implement green technology projects. For example, schools can partner with communities to build school gardens that use organic farming techniques or sustainable irrigation systems. This model not only strengthens the relationship between the school and the community, but also instills sustainability values among students and the surrounding community.

The importance of the role of teachers in implementing educational models that support sustainable development through green technology cannot be ignored. According to Rahman (2019), teachers must have a deep understanding of the concepts of green technology and sustainability, and be able to integrate these concepts into various subjects. Teacher training and professional development are key to ensuring that they have the skills and knowledge needed to support sustainability-oriented learning.

One example of the implementation of green technology in education is through the development of environmental laboratories equipped with green technology, such as solar panels, wastewater treatment systems, and recycling devices. These laboratories not only function as a place of learning for students, but also as a center for research and development of green technology that can be utilized by the surrounding community. With facilities like this, students can learn about green technology directly, as well as understand the importance of innovation in achieving sustainable development goals.

In addition, the use of green technology in educational facilities, such as environmentally friendly school buildings, is also part of an educational model that supports sustainable development. The design of school buildings that optimize the use of energy, water, and environmentally friendly materials can be a concrete example for students of how green technology can be applied in everyday life. It also helps create a healthy and comfortable learning environment, which in turn can improve students'

academic performance.

Educational models that support sustainable development through green technology should also consider the use of digital technology as a learning tool. E-learning or digital-based learning can reduce carbon footprints by reducing the need for printed materials and transportation. In addition, digital platforms allow wider access to educational resources on green technology and sustainability, which can be accessed by students from various socio-economic backgrounds.

Developing a curriculum that integrates green technology and sustainability is another important step. This curriculum should cover various aspects of green technology, such as renewable energy, waste management, and energy efficiency, and how these technologies can be applied in the local context. This curriculum should also be supported by relevant and up-to-date teaching materials that can help students understand and apply green technology concepts in their lives.

In Indonesia, several educational institutions have begun to adopt educational models that support sustainable development through green technology. For example, educational programs in several Islamic schools teach students about the importance of protecting the environment through the use of green technology in daily activities. According to Zulkarnain (2021), this initiative not only helps students understand the importance of sustainability but also teaches them Islamic values about environmental responsibility.

In addition, collaboration between educational institutions and the green technology industry is also an effective model in supporting sustainable development. Industry can provide support in the form of technology, funding, and practical knowledge that can be used by educational institutions to develop programs that are relevant to market needs. This kind of collaboration can accelerate the adoption of green technology in the education sector and increase the relevance of education in facing global challenges.

However, challenges in implementing educational models that support sustainable development through green technology remain. One of them is the lack of resources, both in terms of funds and technology, needed to implement these models effectively. In addition, resistance to change, both from teachers and students, can also be a barrier to adopting green technology in the education sector. Therefore, support from the

government and other stakeholders is needed to overcome these challenges and ensure the success of educational models that support sustainable development.

In conclusion, educational models that support sustainable development through green technology have great potential to create an environmentally conscious generation that is ready to face future challenges. By integrating green technology into education, we not only help achieve sustainable development goals, but also equip young people with the skills and knowledge they need to become positive agents of change for the environment. Therefore, efforts to develop and implement these models must continue to be encouraged and supported by all parties involved.

## **RESEARCH METHODS**

This study uses a library research method, where the data used comes from various literatures relevant to the topic. Library research is a method carried out through the collection and analysis of existing related literature without conducting experiments or collecting data directly from the field. Library research aims to review and analyze previous relevant scientific works in order to find, explain, and understand concepts or theories that support the arguments presented.

In library research, the data sources used consist of books, scientific journals, articles, and other documents relevant to the research topic. This secondary data is analyzed by identifying theories, concepts, and previous findings related to the research problem. Sugiyono (2017) explains that library research is important to find a strong theoretical basis and help researchers clarify the research context. In addition, library research can also be used to identify research gaps that have not been discussed by previous research.

Data analysis techniques in library research are carried out through the process of identification, evaluation, and synthesis of relevant literature. The data obtained are then analyzed critically to understand the relationship between concepts and compile a synthesis of findings related to the focus of the research. According to Zed (2014), library research requires a deep understanding of relevant literature so that researchers can formulate strong arguments. The analysis process is also carried out by mapping various existing findings and comparing them with the theories used in this study.

In terms of data collection techniques, library research uses documentation studies

as the main tool. Arikunto (2010) stated that documentation studies are one of the effective data collection methods for library research, because researchers can access information that has been tested for credibility and is academically recognized. The use of secondary data from various sources also allows researchers to compare findings from various literatures and draw conclusions based on the synthesis of previous theories and research.

Therefore, this library research method is very relevant to be used in this study, because it can help researchers identify and elaborate theories and concepts that support research problems. By using various valid and accredited literature, this study is expected to provide academic contributions in developing a broader understanding of the topic being studied.

## **RESULTS AND DISCUSSION**

### **Project based learning about green technologies**

Project-based learning (PBL) on green technology offers an innovative approach to directly engage students in relevant and applicable learning experiences. This approach emphasizes the application of knowledge in real-world contexts through green technology-related projects, which provide students with the opportunity to learn while engaging in practical solutions to environmental issues. According to Suryadi (2021), this learning model facilitates a deeper understanding of green technology principles and allows students to develop practical skills needed in related industries. By engaging students in real-world projects, they can see how green technology is applied and functions in everyday life contexts.

In project-based learning, students are given the task of designing and implementing a project related to green technology, such as developing a renewable energy system for a school or designing a waste management solution. Rahmawati (2021) explains that this model not only focuses on the final results of the project, but also on the learning process that occurs during the implementation of the project. Students learn about the principles of design, planning, and project implementation, as well as how to overcome challenges that arise during the process. In this way, learning becomes more contextual and relevant to real needs in the field.

This learning model also encourages collaboration and teamwork among

students. According to Fauzan (2022), projects involving green technology often require collaborative skills, as they involve various technical and non-technical aspects. Collaboration between students in planning, implementing, and evaluating projects allows them to learn from each other, share knowledge, and develop communication and project management skills. This is a valuable experience that equips students with important skills for their future in the professional world.

In addition, project-based learning often involves the involvement of local communities and stakeholders. Abdullah (2020) noted that involving external parties such as environmental organizations, green technology companies, and local communities in projects can broaden the impact and relevance of the project. For example, an energy management project in a school involving collaboration with a renewable energy company not only improves student learning outcomes but also provides direct benefits to the community. This creates synergy between education and real-world practice, and strengthens the relationship between the school and the community.

The application of green technology in learning projects also provides an opportunity for innovation exploration. Nasruddin (2020) revealed that projects that focus on green technology often involve the application of the latest technology and innovative solutions to environmental problems. Students are encouraged to think creatively and find solutions that are not only efficient but also environmentally friendly. By facing complex challenges and developing new solutions, students can hone innovation and creativity skills that are important in the world of green technology.

Evaluation is an important component in the project-based learning model. According to Hidayat (2019), assessment in this model does not only focus on the final results of the project but also on the processes and skills developed during implementation. Assessment can cover various aspects such as planning, implementation, teamwork, and problem-solving skills. With this approach, evaluation provides a more holistic picture of student performance and their achievements in the project.

Project-based learning also contributes to the development of environmental awareness among students. Aziz (2021) points out that direct involvement in

environmental projects allows students to better understand the impact of green technology on the environment and society. They not only learn about the theory but also experience firsthand how green technology can be used to address environmental issues. This helps build more environmentally responsible attitudes and behaviors.

One of the challenges in implementing project-based learning is the need for adequate resources. Fauzan (2022) noted that implementing projects involving green technology often requires facilities and materials that may not be available in all schools. Therefore, it is important to have support from various parties, including government, industry, and communities, to provide the necessary resources. With this support, schools can overcome limitations and ensure that projects can be implemented properly.

This model also requires effective planning and coordination between educators and students. According to Nasruddin (2020), the success of a project depends largely on how the planning is done and how tasks are divided among team members. Educators need to provide adequate guidance and ensure that students understand the objectives of the project, the steps to be taken, and how to overcome any problems that may arise. Good coordination helps ensure that the project runs smoothly and achieves the desired results.

Overall, project-based learning in green technology offers an effective model for engaging students in relevant and applicable learning experiences. By integrating green technology principles into real-world projects, students can develop important practical skills, creativity, and environmental awareness. Adequate resource support, good planning, and community involvement are key to ensuring the success of this model and providing maximum benefits to education and the environment.

### **Continuous curriculum integrated with Islamic education**

The sustainable curriculum integrated with Islamic education focuses on combining religious teachings with the principles of environmental awareness, creating a holistic approach to education. This curriculum model aims to integrate Islamic values with environmentally friendly practices, ensuring that students not only understand their religious teachings but also how to apply them in the context of environmental protection. According to Hidayat (2020), this approach allows students to learn about

their environmental responsibilities through the lens of Islamic teachings, bridging the gap between spiritual principles and the practical needs of preserving our planet.

In this curriculum structure, subjects and learning activities are designed to cover sustainability themes that are in line with religious teachings. Rahmawati (2021) explains that this integration is done by including topics such as natural resource management, environmental protection, and the use of green technology in religious lessons. This curriculum aims to teach students how Islamic teachings support the principles of sustainability and how they can apply these teachings in their daily lives to protect the environment.

Sustainable curriculum integrated with Islamic education also involves the application of learning methods that support active student involvement in environmental issues. Abdullah (2020) noted that methods such as project-based learning and case studies can be used to connect religious teachings with sustainability practices. Through this method, students not only learn theory but also directly engage in activities that promote sustainability, such as greening projects or waste reduction campaigns at school.

The implementation of these curriculum principles also includes training for educators to ensure that they are able to teach the material in a relevant and engaging way. According to Fauzan (2022), this training includes an in-depth understanding of how to integrate religious teachings with environmental concepts and effective teaching techniques. Educators are empowered to deliver material that connects religious values with environmental responsibility, creating a supportive learning environment and motivating students to behave more sustainably.

Furthermore, this curriculum often involves holistic assessment, which evaluates not only academic knowledge but also the application of sustainability principles in everyday actions. Nasruddin (2020) explains that the assessment in this curriculum includes observations of student behavior, sustainability projects they participate in, and their participation in environmental initiatives at school. This approach provides a more complete picture of the extent to which students can integrate religious teachings with sustainability practices.

In addition, this sustainable curriculum also requires support from various parties, including the school community and the wider community. Aziz (2021) stated

that the involvement of parents, local communities, and environmental organizations can strengthen the implementation of the curriculum by providing additional resources, such as teaching materials and opportunities to participate in environmental activities. This external support helps ensure that the curriculum can be implemented more effectively and provide wider benefits to students and the community.

The importance of continuous curriculum development is also reflected in the need for continuous evaluation and improvement. According to Suryadi (2021), periodic evaluation of the curriculum and teaching practices is essential to ensure that the material remains relevant to the latest developments in environmental science and Islamic education. This evaluation process involves feedback from educators, students, and other stakeholders to identify areas for improvement and ensure that the curriculum continues to meet its objectives.

The implementation of this sustainable curriculum can also contribute to the creation of a school culture that supports sustainability. Hidayat (2020) shows that by integrating religious teachings and environmental principles into the curriculum, schools can create an environment that emphasizes sustainable values and inspires students to adopt environmentally friendly behaviors. This culture not only affects students but also staff and the school community as a whole.

In the long term, a sustainable curriculum integrated with Islamic education can help create a generation that is more environmentally aware and more skilled in managing natural resources. Rahmawati (2021) stated that by teaching students about the importance of environmental responsibility through religious teachings, they will be better prepared to face future environmental challenges and contribute to sustainable development in their communities.

Overall, a sustainability curriculum integrated with Islamic education offers an effective approach to connecting religious teachings with sustainability practices. By integrating spiritual values and environmental principles into education, this curriculum can prepare students to become responsible leaders in caring for our planet, while strengthening their understanding of religious teachings and their responsibility to the environment.

### **Developing students' skills in green technology innovation**

Developing students' skills in green technology innovation is a crucial aspect of education that aims to prepare the next generation to contribute significantly to the environmental and technology sectors. Education that focuses on green technology innovation not only provides technical knowledge but also equips students with the practical skills needed to face global environmental challenges. According to Hidayat (2020), education that integrates green technology aspects into the curriculum enables students to develop critical and creative skills needed to design innovative solutions to environmental problems.

One effective way to develop these skills is through a project-based learning approach that engages students in the development and application of green technologies. Rahmawati (2021) explains that through practical projects, students can apply the concepts they have learned in real situations, such as designing renewable energy systems or waste management solutions. This approach not only strengthens students' understanding of green technologies but also develops problem-solving and teamwork skills that are essential in this sector.

In addition, the integration of green technology into the curriculum often involves the use of the latest tools and devices related to environmental innovation. Fauzan (2022) emphasized that by introducing students to the latest technologies, such as solar panel systems or energy efficiency technologies, they can gain practical skills that are relevant to industry needs. Hands-on experience with these technologies not only enhances students' technical understanding but also motivates them to pursue a career in green technology.

Student skill development also requires training and guidance from industry experts and practitioners. Abdullah (2020) stated that professional involvement in the learning process can provide students with deeper insights into the latest trends and best practices in green technology. Internship programs, field trips, and collaborations with green technology companies provide opportunities for students to learn directly from experts and apply their skills in a professional context.

Innovation skills can also be strengthened through competitions and events that focus on green technology. Nasruddin (2020) points out that students' participation in green technology competitions provides them with the opportunity to hone their skills,

explore new ideas, and receive constructive feedback. These competitions often create a challenging environment and motivate students to innovate and think outside traditional boundaries.

A successful educational program should also include an emphasis on entrepreneurship and business development in the context of green technology. According to Aziz (2021), equipping students with entrepreneurial skills enables them to not only work in the green technology industry but also create their own businesses focused on sustainability solutions. Entrepreneurship education integrated with green technology prepares students to become innovative leaders in the future.

Effective evaluation is also an important part of developing students' skills in green technology innovation. Hidayat (2020) emphasized that assessment should cover both practical and theoretical aspects of green technology, ensuring that students not only understand the concepts but are also able to apply them in real situations. Comprehensive assessments can include projects, presentations, and performance-based evaluations that provide a comprehensive picture of students' abilities.

In addition, the development of these skills requires support from various parties, including the government, industry, and educational institutions. Fauzan (2022) emphasized the importance of collaboration between educational institutions and the industrial sector in providing resources, training, and opportunities for students. This support is essential to ensure that educational programs remain relevant and meet the needs of the evolving labor market.

A curriculum that focuses on green technology must also be flexible and adaptable to the latest technological developments. Rahmawati (2021) suggests that the curriculum should be updated regularly to reflect innovations and changes in the green technology industry. With continuous curriculum updates, students will always get the latest and relevant information and skills.

Finally, developing students' skills in green technology innovation contributes to the creation of a generation that is more environmentally conscious and more skilled in addressing global challenges. According to Suryadi (2021), by providing education that prepares students to contribute to the environmental and technology sectors, we are not only preparing them for successful careers but also to become agents of positive change in society.

## CONCLUSION

Developing students' skills in green technology innovation, education collaboration with the green technology industry, and developing green technology-based curriculum are interrelated in creating a holistic and relevant education system to face future environmental challenges. These three aspects show that the integration of green technology education and practice not only prepares students to contribute to the environmental sector but also plays a vital role in advancing innovation and sustainability solutions. By adopting a project-based approach, engaging industry, and continuously updating the curriculum, education can equip students with the practical skills and knowledge needed to face global challenges.

Overall, the implementation of these educational models can create a generation that is not only skilled in green technology but also has a deep environmental awareness. Collaboration between educational institutions and industry, together with flexible and integrated curricula, forms a strong foundation for advancing innovation and sustainability. By focusing on the development of relevant practical and theoretical skills, and providing support from various parties, we can ensure that students are prepared to become leaders in protecting and preserving our planet, and advancing the green technology sector in the future.

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