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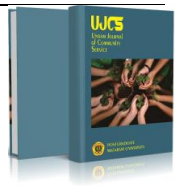

Promoting STEM-Creative Skills in High School Students: Renewable Energy in Island Regions

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Abstract: This community service activity aims to increase students' understanding of renewable energy through a STEM education approach at SMA Negeri 57 Maluku Tengah. In this activity, students are invited to design and build a simple windmill model, which not only introduces basic physics concepts but also encourages their creativity and critical thinking skills. The main results of this activity show that students experienced an increase in knowledge and practical skills related to renewable energy. In addition, they also showed an increased interest in science and technology, as well as the ability to collaborate in groups. The main conclusion of this activity is that a project-based approach in STEM education is effective in developing 21st-century skills in students, as well as the importance of integrating the concept of renewable energy into the curriculum to prepare the younger generation to face environmental challenges in the future. This activity also emphasizes the need for teacher training to support the implementation of better STEM education. Thus, strengthening STEM education that focuses on renewable energy can be a strategic step in preparing students to face increasingly complex environmental challenges.

Keywords: Creative thinking, STEM, renewable energy, wind turbines, archipelago.

Introduction

Creativity is the ability to have a different perspective, go beyond the given information and push boundaries, be unconventional, be unique, combine unrelated things and do something new (Tolleson & Zeligman, 2019). There are many scientific findings that show that the development of creative skills in individuals is based on the support of these skills in early childhood. Scientists state that the golden age of creativity is the preschool years (Alfonso-Benlliure et al., 2013). At that time, children naturally draw, dance, tell stories by making up stories in their own way and creating them spontaneously by finding creative ways.(van Broekhoven et al., 2020)Children are born with creativity that needs to be developed from preschool. Creativity is a process that requires the expression of new, surprising, and valuable ideas that not every individual possesses, the ability to consider multiple perspectives, go beyond existing information, and create original products (Genek & Küçük, 2020). Creativity is a fundamental aspect of human cognition and problem solving, enabling individuals to generate new and valuable ideas, perspectives, and solutions (Marozzo et al., 2024). Therefore, to give birth to a creative generation, creativity education must start from an early age (Maslin et al., 2024). An educational environment that can support children's creativity is only created when it is designed in such a way that children can freely work with various materials, their thoughts and creativity can emerge, and when it is designed in such a way as to support non-conventional and conventional thinking (Anwar et al., 2024) In such an environment, children who face various problems can have the opportunity to understand the problems, become aware of the problems, and conduct experiments and develop their creative attitudes and behaviors (Liu & Green, 2024). In the studyMakhmalbaf & Yi-Luen Do (2007)states that the environment can influence children's creativity. An environment rich in

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materials, toys, and equipment has a positive impact on children's creativity. Izquierdo-Sanchis et al., (2025) examined the impact of school environment and creativity on children's development. Overall, it appears that providing children with enriching environmental opportunities has a positive impact on their creativity.

To enhance scientific creativity, teachers need to support the use of open-ended questions. Thus, students should be able to ask open-ended questions that are sufficient to solve problems.(Batlolona et al., 2019)Teachers also need to encourage students to apply techniques such as brainstorming (Siew et al., 2015). In addition, it is important for teachers to develop students' critical thinking skills and product creation abilities. In other words, to stimulate creative thinking, teachers must provide opportunities for students to formulate hypotheses to solve problems, design experiments, and keep up with technological developments (Lin et al., 2003;Leasa et al., 2025). Creative thinking requires students to be able to study and understand natural objects or phenomena. However, the facts on the ground are based on the results of studies reported by Leasa et al., (2021), it was found that students' creative thinking skills in the Maluku Islands are still relatively low. Therefore, continuous and comprehensive learning improvements are needed to enhance students' creative thinking skills. Teachers must plan strategies to support student creativity and innovation. Creative teaching and learning can attract students' attention to explore new things through problem-solving. Studies show a strong relationship between creative teaching and learning approaches in the context of STEM education (Eroglu et al., 2022). Based on all these reasons, STEM education-based activities are used in this activity.

The United States has failed to attract young people to scientific and mathematical ideas. Although science is well supported in US society in general, there is a shortage of qualified individuals to prepare the next generation (Avendano et al., 2019) However, things are changing very quickly and they are much more advanced, where STEM is becoming increasingly important for competitiveness and economic growth in the United States (Pecen & Nayir, 2010). Modernization has influenced STEM education, and teachers must be creative by using various interesting approaches (Othman et al., 2022). Study Weng et al., (2022) concluded that the CT-STEM strategy encourages students' creativity, competence, and motivation to find more solutions to problems. This finding is in line with the opinion Vieira et al., (2025), which states that STEM education effectively influences students' creative thinking skills compared to conventional learning methods. The creativity fostered through STEM education helps students better understand the material and improves their problem-solving abilities and motivation (Hebebci & Usta, 2022). This, in turn, can increase self-confidence and teamwork and enable students to integrate their knowledge with the engineering design process (Pont-Niclòs et al., 2024).

Furthermore, based on creativity findings from diary entries from various studies, it was found that children's creative thinking skills improved, collaboration among them also increased, and peer learning was fostered. Furthermore, children's self-confidence increased, active learning occurred, and this process encouraged them to generate new ideas. This also helped children reflect on the skills they have acquired in school and outside of school, as well as developing empathy among themselves (Yalçın & Erden, 2021). During STEM implementation, children seek solutions to the problems presented and integrate their creativity into the solutions found, while diverting attention from the subject matter and seeking different alternatives. The implementation of STEM makes the collaborative learning process among children more effective. It can be concluded that children experience development in several aspects and incorporate their personal ideas into group designs (Conradty et al., 2018). Elementary and high school years have a positive impact on shaping students' perceptions of learning and their future career choices (Bryan & Guzey, 2020). However, the middle school years represent an optimal time to implement STEM education initiatives and programs (Cheryan et al., 2011; Lesseig et al., 2017) Students who are interested in STEM in high school are more likely to pursue STEM fields in college (Maltese et al., 2014; Thomas & Larwin, 2023) However, despite the increase in STEM programs in middle schools, diversity among STEM college graduates appears to be stagnant (Premraj & Thompson, 2019).

Although some countries (e.g., Australia, England, Estonia, Finland, Hong Kong, Hungary, Iceland, Ireland, New Zealand, Scotland, Singapore, South Korea, and Taiwan) have incorporated creativity into their educational programs, the main focus is still on creative thinking (Patston et al., 2021) Education in Saudi Arabia has recently emphasized creativity and considered it a fundamental skill in K-12 education. Therefore, this study assumes that Saudi teachers encourage and teach creativity in science classes. However, it remains unclear how STEM teachers develop students' creativity (Bojulaia, 2025). The same study also found that STEM education can improve students' creativity, collaboration, communication, digital literacy, and scientific literacy (Yang et al., 2025). This exclusive focus on the cognitive aspects of creativity poses significant challenges, particularly for women in Australia, who tend to underestimate their creative abilities, resulting in their underrepresentation in STEM fields (Karwowski, 2011).

Students can overcome the anxiety that creative activities bring by being guided to anticipate such uncertainty and recognizing that throughout history, it has been a natural component of the process of generating new ideas, which is one aspect of epistemic confidence. Generating creative ideas or products in STEM activities is not easy, and involves two interrelated processes that are key to all creative endeavors: generating and evaluating alternatives. The greater the ability to move between these two processes and execute them efficiently, the more likely it is that creative ideas or products will be generated (Wan et al., 2021) Existing information indicates that STEM education is crucial as a way to prepare students with the 21st-century skills needed to solve complex real-world problems (Dertli & Yıldız, 2024). However, its application to students in island regions, particularly in Maluku, remains limited, particularly among students at State Senior High School 57, Central Maluku. This is because the school curriculum has not been designed to facilitate this. Teachers also lack a strong STEM foundation. Therefore, a teacher training program for STEM integration is essential and can be implemented in the classroom. State Senior High School 57, Maluku, is located in Allang Village, which is ideally located. The Allang area boasts strong wave and wind power. This situation has long been known by ship captains. The popular term for this is Cape Allang, with strong winds and waves, making it a potential source of clean electricity. Potential areas like this are excellent for STEM learning, making it ideal for equipping students to utilize the surrounding nature to become a strength and future regional growth.

A broader portrait, where Indonesia has a high renewable energy potential of 419 GW, consisting of 75 GW of hydro energy, 23.7 GW of geothermal energy, 32.6 GW of bioenergy, 207.8 GW of solar energy, 60.6 GW of wind energy, and 19.3 GW of microhydro (Pambudi et al., 2023). Maluku Province has significantly more solar energy potential than other renewable sources, followed by biomass, wind, and hydropower. If properly utilized, Maluku could become an energy-independent region based on renewable resources (Tumiran et al., 2022) However, electricity distribution remains inadequate, leaving many small, remote islands unreachable. This highlights the need for decentralized renewable energy solutions, such as tidal energy systems, to improve energy access and sustainability in these underserved areas. This gap is why community service activities are being conducted. Although interest in STEM is still relatively new, experts have emphasized the importance of professional development for teachers for the successful implementation of STEAM in schools to prepare students for life in the future (Cook & Bush, 2018). Without adequate training and support in pedagogical and content knowledge, teachers have difficulty integrating STEAM content and activities (Boice et al., 2021).

Method

A community service program held by a community service group from the Physics Education study program, Pattimura University consisting of Jamaludin, S.Pd., M.Sc (Physics) and John Rafafy Batlolona, S.Pd., M.Pd (Physics Education) and Carolina Sri Athena Barus, S.Pd., M.Pd (Physics Education). The activity was carried out at SMA Negeri 57 Maluku Tengah in Allang Village, involving 20 students from the 12th grade of the science program. Before the activity began, a pretest was conducted. The pretest was conducted to measure students' knowledge and understanding before they participated in certain learning activities. The main purpose of the pretest was to obtain an overview of the level of students' readiness in understanding the material to be taught. In addition, providing a pretest before learning can help students learn and encode important concepts taught in subsequent lessons (Janelli & Lipnevich, 2021). This activity is designed to provide students with a deeper understanding of renewable energy through an interactive and practical approach. It is divided into two sessions, each with different objectives and methods, but complementing each other to create a holistic learning experience.

Session One: Introduction to Renewable Energy. In the first session, the main focus is on introducing the concept of renewable energy. Renewable energy is energy sources that can be naturally renewed in a relatively short time, such as solar, wind, hydro, and biomass. In this section, students will be encouraged to understand the importance of renewable energy in the context of the environment and sustainability.

1. Explanation of Renewable Energy Material
   a) Definition and Types of Renewable Energy
      Students will learn about different types of renewable energy, including solar, wind, hydro, and biomass. This course will cover how each of these energy sources is produced and used.
   b) Benefits of Renewable Energy
      Students will understand the benefits of using renewable energy, such as reducing carbon emissions, reducing dependence on fossil fuels, and contributing to environmental sustainability.
   c) Challenges in Using Renewable Energy
      Students will also be introduced to the challenges faced in the development and implementation of

renewable energy technologies, such as high initial costs and variability of energy sources.

2. Renewable Energy Video Show
   a) The videos shown will provide a clear visualization of how renewable energy is generated and implemented in various parts of the world. Through these videos, students can see real-life examples of renewable energy projects, such as wind farms and solar panels, and their impact on society and the environment.
   b) Discussions after the video screening will encourage students to share opinions and ask questions, creating an interactive atmosphere that supports deeper understanding.

Session Two: Making a Paper Turbine STEM Project

After the introductory session, students will be invited to do a practical project that will combine the knowledge they have gained with technical skills.

1. Making a Turbine Project from Paper

In this project, students will work in groups to design and build a simple wind turbine using paper and readily available materials. The project aims to teach students the basic physics principles underlying wind energy and how it can be converted into mechanical energy.

2. Steps of Making
   a) Turbine Design: Students will design the optimal shape and size of turbine blades to capture wind energy.
   b) Construction: Using paper, students will build their turbine, which may include the use of glue, scissors, and other simple tools.
   c) Testing: Once the turbine is complete, students will test it using a wind source (e.g., a fan) to see how effective their turbine is at generating energy.
3. Learning Through Practice
   a) This project not only teaches students about renewable energy but also encourages critical and creative thinking. Students will learn about engineering processes, teamwork, and problem-solving.
   b) Upon completion of the project, each group will present their work, explaining their turbine design and test results. This provides an opportunity for students to practice their communication and presentation skills.

This activity aims to provide a comprehensive understanding of renewable energy through a combination of theory and practice. By dividing the activity into two sessions, students not only gain basic knowledge about renewable energy but also practical skills that can be applied in everyday life. Through this experience, it is hoped that students will better appreciate the importance of renewable energy and contribute to future environmental sustainability. As a final step, students are asked to present their projects to other groups. This sharing session provides an opportunity for participants to exchange ideas, provide constructive feedback, and explore ways they can adapt the projects to their teaching practices. Following the presentations, students engage in reflective discussions—not only to evaluate the projects themselves but also to discuss how they can be integrated into science lessons and connected to other subject areas. They are encouraged to align the projects with relevant learning objectives and topics in the curriculum. In the final phase, students are given a post-test. The purpose of the pretest before the lesson is to analyze students' understanding of the topic and, most importantly, to increase student focus, while the post-test after the lecture aims to evaluate students' learning of key pharmacology concepts (Shivaraju et al., 2017). Overall, this training successfully equipped students with the skills to implement STEM learning that aligns with one of the core components of the Independent Curriculum, the P5 Project.

Result and Discussion

Before beginning the learning activities, the community service team took a series of strategic steps aimed at providing appreciation and motivation to the students. Many of the students expressed shyness and apprehension, especially since this was their first experience learning physics under the guidance of a lecturer. They had a strong assumption that lecturers were individuals with a high level of knowledge and competence in teaching at a university. Furthermore, the students revealed that physics is a very challenging subject, with its abstract nature making it difficult to understand. Some students also stated that the process of solving mathematical problems often made them feel bored, as it requires a deep understanding and mathematical logic. Previously, teaching provided by teachers in the classroom tended to focus less on real-world contexts and applications. Most of the teaching relied more on theoretical sources from physics textbooks provided by the school and information from the internet, without connecting them to everyday life. Modern teaching approaches that should involve the use of interactive learning media, such as applications accessible via mobile devices and physics projects that can be assembled collaboratively with friends, did not appear to be implemented optimally.

Therefore, based on the various information and aspirations conveyed by the students, the community service team led by Jamaludin, S.Pd., M.Sc. provided the necessary reinforcement. Before starting the lesson, the team also confirmed the students' understanding of

renewable energy, as shown in Figure 1. This step is expected to create a more conducive learning atmosphere and reduce students' anxiety, while increasing their interest in physics.

Figure 1. Confirming Students' Understanding of Renewable Energy

Jamaludin, S.Pd., M.Sc and John Rafafy Batlolona, S.Pd., M.Pd showed a video on renewable energy as in the following link: https://www.youtube.com/watch?v=jSMkRU0e2tY&t=306s and provide material on the potential of renewable energy sources in Maluku, which is an archipelago with a lot of potential, in the form of study results. Tumira et al., (2022) shows that based on the power capacity that can be generated (in megawatts, MW).

1. Hydro (109.6 MW): Maluku's hydropower potential is quite limited compared to other sources. This is likely due to the relatively small size of its rivers and the lack of large flows. However, it can still be utilized for micro-hydro power generation in certain areas.
2. Wind (404.8 MW): Wind power potential in Maluku is significant, given that this archipelago has numerous coastal areas with relatively stable wind speeds. This energy could be an alternative electricity source, especially on small islands.
3. Solar (496,587.9 MW): This represents the greatest potential. This very high figure reflects Maluku's abundant solar radiation almost year-round, making solar energy the most promising resource for widespread development.
4. Biomass (18,385.3 MW): Biomass potential is also significant, supported by Maluku's natural resources, such as agricultural, plantation, and forestry waste. This energy can be processed to meet local electricity needs while reducing dependence on fossil fuels.

Figure 2. Showing Renewable Energy to Students

Global warming and greenhouse gas emissions have become major issues worldwide and renewable energy has emerged as an important energy source to be developed and maintained in order to address these issues in the future (Ang et al., 2022). Various types of renewable energy technologies, such as biomass, wind power, hydro, and geothermal, have been proven safe and effective in reducing the impact of global warming.(Sims et al., 2003)Indonesia's energy transformation policy towards the use of renewable energy sources must be significantly promoted and strengthened to achieve more ambitious goals. In this context, Indonesia has established a clear vision and mission to achieve a 23% contribution of renewable energy in the primary energy mix by 2025, accompanied by a relative greenhouse gas emission reduction target of 29% to 41%.(Santika et al., 2020)Comparatively, most ASEAN member states currently only allow renewable energy deployment to reach 16.9%, representing a significant gap of 6.3% from the desired target. To address this gap, every country in the region, including Indonesia, must play an active role in increasing the share of renewable energy in their national energy mix.(Yudha & Tjahjono, 2019)This effort will not only strengthen national energy security but also contribute to achieving sustainable development goals and mitigating climate change globally.

This current situation necessitates proactive efforts to empower STEM students to ensure they are equipped with essential skills to face the challenges of technological development and help Indonesia become a developed nation. For example, in Malaysia, the number of students enrolled in STEM subjects has been declining, with the ratio of science classes to arts classes having reached one in five in recent decades.(Hisyam et al., 2019)The Indonesian government has made efforts to improve the STEM curriculum at the primary and secondary levels, but still faces challenges in

implementing it equitably across the region, particularly in remote areas. A comparison of education across ASEAN countries is shown in Table 1.

Kampen et al., (2004) conducted an in-depth study to emphasize the significance of a learning process focused on renewable energy for students, which is currently still dominated by traditional lecture methods. They argued that this approach needs to be replaced with problem-based learning that integrates practical activities, so that students can be actively engaged in the learning process. Science tools in the context of STEM education have the potential to develop students' metacognitive abilities during the learning process, which in turn can enhance their critical thinking skills. For example, the use of wind turbine devices in the STEM education system in Malaysia is still relatively rare, making careful attention to each stage of the development of science tools crucial. This aims to ensure that the devices not only facilitate the utilization of natural resources but also connect them to students' daily activities, thus making them relevant to STEM practices in teaching. This situation is also relevant to teaching in Indonesia, particularly at SMA Negeri 57 in Central Maluku. There are still few initiatives that involve students in learning about the sustainability of wind energy through STEM education. Awareness of the importance of this integration is crucial for future generations, in order to instil a deep interest and understanding of the importance of sustainable energy (Bakar et al., 2022). Thus, strengthening STEM education with a focus on renewable energy can be a strategic step in preparing students to face increasingly complex environmental challenges in the future.

Table 1. Overview of education in Southeast Asian countries

Country	Education and Education Policy
Brunei	Education in Brunei is of relatively good quality and offers a variety of learning programs.
Cambodia	Education in Cambodia is in a development stage and requires investment to improve its quality.
Indonesia	Education in Indonesia is in the development stage and many efforts have been made to improve its quality.
Laos	Education in Laos lacks adequate infrastructure, equipment and high-quality teachers.
Malaysia	Education in Malaysia is currently in a development stage and many reforms have been implemented to improve the quality of education.
Myanmar	Education in Myanmar still has many limitations, including a lack of equipment, insufficiently qualified teachers, and outdated learning programs.
Philippines	The education system in the Philippines still has many limitations, including a lack of equipment and insufficiently qualified teachers.
Singapore	Singapore's education system is considered one of the best in the world, with high-quality education and highly qualified teachers.
Thailand	Education in Thailand is of relatively good quality, but still faces many challenges that need to be addressed.
Vietnamese	Education in Vietnam is in a development stage, and many reforms have been implemented to improve the quality of education, but there are still many challenges that need to be overcome.

Source: (Tuyet et al., 2024)

STEM Development in Southeast Asia

Several pioneering countries, such as Singapore and Malaysia, have placed significant emphasis on STEM education at the primary school level. These countries have comprehensive STEM teaching programs starting from primary school and have made significant investments in infrastructure, equipment, and high-quality teachers to ensure quality teaching. However, in several other countries in the region, such as Vietnam, Thailand, the Philippines, and Indonesia, STEM education is still in its infancy and requires improvement. Schools in these countries still lack equipment, adequately skilled teachers, and curriculum updates to meet international standards. Although governments have integrated STEM into their secondary school curricula, these countries still face challenges related to equipment shortages, underskilled teachers, and the need for curriculum updates to align with international standards (Tuyet et al., 2024).

In 2018, Vietnam began integrating STEM and STEAM education into the national curriculum with the aim of effectively implementing STEM education at the primary and secondary levels to develop students' holistic abilities (Trang et al., 2021) Vietnam has recognized that systematically implementing STEM in the national curriculum requires a long-term plan that includes an implementation roadmap at various levels and in appropriate formats, not just a temporary trend. Most importantly, there must be coordinated guidance and awareness among educators and teachers. Implementing experiential learning activities within STEM-focused education helps develop scientific skills, sparks interest in exploring real-world problems, and creates products that can solve problems faced by students. Professional development should be emphasized within the context of STEM thinking and career awareness in STEM fields. This creates a supportive environment for "realizing STEM education for sustainable development goals" in Vietnam (To

Khuyen et al., 2020) However, while significant efforts have been made to improve the quality of STEM teaching in Southeast Asia, governments and non-governmental organizations have invested in various projects and teacher training programs to improve the quality of STEM teaching. Furthermore, schools, organizations, and businesses are collaborating to integrate STEM education to create a smarter and more creative generation of students in the future.

STEM Teaching for Students

STEM provides students with the opportunity to design and build a functioning windmill, while considering how similar devices could generate environmentally friendly energy for future energy needs. The relevance and appeal of this challenge are further enhanced by the inspiring story and useful solution developed by an African teenager, William Kamkwamba. His story, first told in a book and now adapted into a film, "The Boy Who Harnessed the Wind," offers many valuable learning moments. This challenge also provides a good opportunity to teach or review the basic concepts and causes of wind. For students, it is important to explain that wind is air in motion, and that we can harness wind energy for beneficial purposes. Windmills, which have been used for centuries to grind grain into flour and pump water, are devices that can harness wind energy. Sustainability is a key issue today. The essence of human existence lies in the sustainable use of energy in everyday life. It is crucial to teach the principles of wise energy use from an early age. Teaching students about energy concepts is shown in Figure 3.

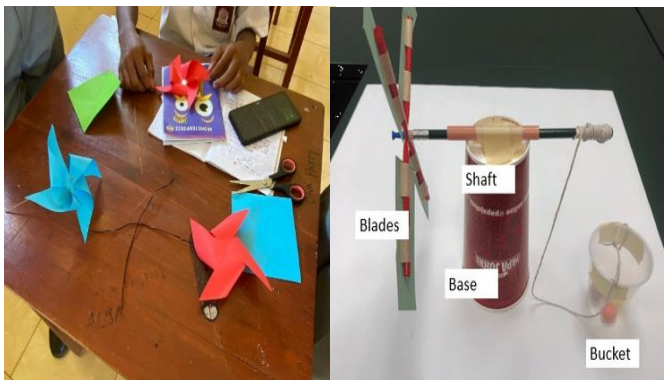

Figure 3. Providing Teaching to Students about the Concept of Energy

A STEM approach provides a strong foundation for introducing renewable energy to students. One of the best ways to introduce wind power is by having them build their own wind turbine. In this process, students will understand the scientific, technological, engineering, and mathematical aspects underlying how wind turbines work. Carefully designed lessons that encompass all STEM elements when teaching wind power will foster students' interest in applying wind power in their daily activities and help them grasp the various related concepts. This paper outlines concepts and activities that can be given to elementary school students to teach wind power. In everyday life, students often struggle to understand the rationale behind learning certain materials. This activity integrates the six cognitive levels of Bloom's Revised Taxonomy. Beginning with remembering and understanding concepts about alternative energy and wind power, the activity then progresses to the application level by designing a wind turbine, analyzing various turbine designs, evaluating wind turbines to refine their designs, and finally creating a wind turbine that can generate electricity and discussing other uses for wind turbines. In addition to leveraging students' higher-level knowledge, science, technology, design, engineering, and mathematics are taught in an integrated and relevant manner.(Varghese & Senan, 2021).

In this STEM challenge, students are expected to build a windmill capable of lifting several small objects and performing useful tasks. The windmill STEM project follows a video and student worksheet from the Georgia Youth Science & Technology Centers (GYSTC). https://gystc.org/harnessing-the-wind-stem-challenge-2/and student worksheets can be accessed at the following link: https://gystc.org/wp-content/uploads/2020/05/Harnessing-the-Wind-SC-Lesson-Plan-w-vocab.pdf. The results of what the students did are shown in Figure 4a.

Figure 4. STEM Projects by Students: (a) Windmills made by students using paper; (b) Video projects from GYSTC as examples for students

A detailed explanation is as follows: Blades; function to capture kinetic energy from the wind. The shape and angle of the wings are designed to maximize efficiency in capturing the wind, which then turns the shaft. The part that connects the wing to other components. When the wing rotates due to the wind, this shaft will also rotate. The energy from the rotation of this shaft can be used to drive other devices, such as

generators. Base; The support for the entire structure. In this model, the base is made of a stable container, which ensures that the turbine does not easily fall when hit by wind. Bucket; serves to hold water or other materials that can be used to demonstrate how the energy from the turbine can be utilized. For example, this bucket can be used to measure how much water can be pumped or lifted using the energy generated by the turbine. This windmill-making activity creates a positive effect in the form of cognitive maturity and innovation in students' feelings, thoughts, and behaviour. In addition, it increases understanding of the concept of wind energy. Students complete design challenges such as building and testing wind turbines. Students are asked to keep notebooks where they design and record scientific experiments, record data and observations, and draw conclusions and reflections. It is concluded that students use interdisciplinary knowledge with problem-based STEM activities; find solutions, understand problems, and collaborate well with their friends. Based on these results, it can be said that STEM education is very effective in developing the skills expected of individuals in the 21st century such as problem solving, critical thinking, and social interaction.

Conclusion

A community service activity conducted by a team from Pattimura University aimed to improve high school students' understanding of renewable energy through a STEM education approach. In this program, students were invited to design and build a windmill model, which not only introduced basic physics concepts but also encouraged their creativity and critical thinking skills. The main results of this activity showed that students experienced increased knowledge and practical skills related to renewable energy, as well as a greater interest in science and technology. The main conclusion of this activity was that a project-based approach in STEM education has proven effective in developing 21st-century skills in students. Furthermore, the importance of integrating renewable energy concepts into the education curriculum became very clear, given the current environmental challenges. This activity also emphasized the need for teacher training to support the implementation of better STEM education, so that students can be equipped with essential skills for facing the future. Thus, strengthening STEM education with a focus on renewable energy can be a strategic step in preparing the younger generation to face future global challenges.

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