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Integrating Environmental STEM Training by Wetland Local Potential to Improve Environmental Literacy of Science Teachers

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Abstract

Based on the results of observations and interviews with science teachers in Banjarmasin, several problems were obtained that teachers faced in implementing learning through the STEM approach. Namely, some science teachers in Banjarmasin are already familiar with STEM learning but have not implemented it in the learning process, the difficulty of teachers in utilizing the local potential of wetlands as a learning resource to be integrated into STEM learning, and the limited ability of teachers in developing interesting STEM learning modules and connecting everyday problems in learning. The Integrating Environmental STEM by Wetland Local Potential training aims to increase the environmental literacy and understanding of science teachers in Banjarmasin. Training science teachers to carry out problem-solving techniques in analyzing the local potential of wetlands to be used as a learning resource integrated with STEM. This community service uses a Participatory Action Research (PAR) approach to empower teachers in integrating STEM in learning. In this STEM learning training, two projects were created for science learning. The first STEM learning project is to make a simple water filter and an Arduino-based smart garden project. Participants responded positively to the Integrating Environmental STEM by Wetland Local Potential training because it improved science teachers' understanding and environmental literacy in Banjarmasin.

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INTRODUCTION

Facing the dynamics of the development of natural science education in Banjarmasin, the role of the Natural Science Teachers' Association has significant relevance in efforts to improve the quality of science learning. The Natural Science Teachers' Association is not just an ordinary discussion forum. Still, it represents an important entity in shaping the direction of learning, supporting the exchange of experiences, and encouraging innovation in teaching practices. However, behind this collaborative spirit, many complex challenges need to be overcome to ensure quality science learning that is relevant to the needs of the times, such as learning with a STEM approach. STEM is an approach to education in which Science, Technology, Engineering, and Mathematics are integrated

with the educational process, focused on solving problems in real everyday life and professional life (Suwardi, 2021).

The results of observations and interviews conducted on January 31, 2024, at the Natural Science Teachers' Association forum at SMP Negeri 19 Banjarmasin obtained several challenges in carrying out STEM-based learning. One of the main challenges science teachers face in Banjarmasin is limited resources. Lack of access to practical equipment and poorly equipped laboratories are significant obstacles in delivering practice-based and experimental learning. Without adequate resources, science teachers face difficulties in providing comprehensive and engaging learning experiences for their students (Zakiyah et al., 2022). In addition, integrating the STEM approach in learning remains a significant challenge. The STEM concept emphasizes the integration of science, technology, engineering, and mathematics in learning, but has not been fully implemented among science teachers. This is because there are still difficulties in planning and integrating STEM into science learning in the classroom, especially by using learning resources around the environment (Putra et al., 2022). Therefore, more intensive efforts are needed to provide relevant and in-depth training to strengthen the understanding and skills of science teachers in implementing the STEM approach in learning. Time management is also a concern in the implementation of STEM-based learning. Time-consuming material preparation, limited learning time, and the complexity of evaluation add to the workload of science teachers. They must find a balance between presenting the material in depth and ensuring that students remain interested and engaged in the learning process (Nurfajariyah & Kusumawati, 2023).

Integration of local potential is an important aspect often overlooked in STEM learning. South Kalimantan, especially Banjarmasin, has abundant natural wealth, culture, and local wisdom, and is known for its wetland environment. Still, the lack of understanding of these potentials means that local potentials have not been optimally utilized in learning. Education that is rooted in the local context not only increases the relevance of learning but also strengthens students' identities with their culture and surroundings (Nuraeni et al., 2024). The observations and interviews with the principal of SMP Negeri 19 Banjarmasin showed that one of the environmental problems that can be raised for STEM learning at SMP Negeri 19 Banjarmasin is the problem of clean water. Currently, the water supply still relies on Tap Water from Banjarmasin. This is considered insufficient for the daily needs of the many teachers and students at the school, especially for worship needs.

However, there are great opportunities for significant growth and change behind all these challenges. Strong collaboration between the Natural Science Subject Teachers' Association, local government, educational institutions, and the community can be key in overcoming the problems faced. With the right support, science teachers can gain access to better resources, more structured training, and more relevant curricula. In addition, community involvement in supporting STEM learning and integrating local potential can also increase the appeal and effectiveness of learning.

Based on the results of observations and analysis of partner situations and problems, the ULM Community Services team needs to plan and assist the Natural Science Subject Teachers' Association related to STEM learning through STEM learning training that integrates local wetland potential in improving the understanding of STEM learning and environmental literacy of science teachers in Banjarmasin. This training aims to: (1) implement IoT-based STEM learning to enhance the understanding of STEM learning for science teachers in Banjarmasin and (2) improve teacher competence in creating a more dynamic and interactive learning environment through modern technology-based training, which can increase student engagement in learning.

Two projects were created that can be used in science learning and provide environmental literacy for teachers and students when implemented in class. The first STEM learning project is to make a simple water filter (Figure 1). This is to overcome the shortage of clean water, which only depends on tap water. Besides that, this training also includes experience in implementing STEM learning with Arduino-based digital technology. In this case, it is related to creating a smart garden project. This smart garden is an Arduino-based project that can be timed to water plants or done via a humidity sensor (Figure 2).

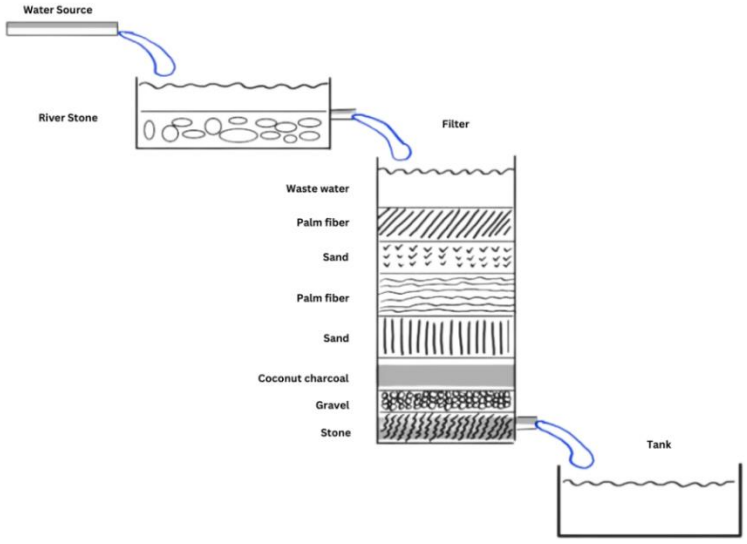

Figure 1 STEM project schematic: making a simple water filter

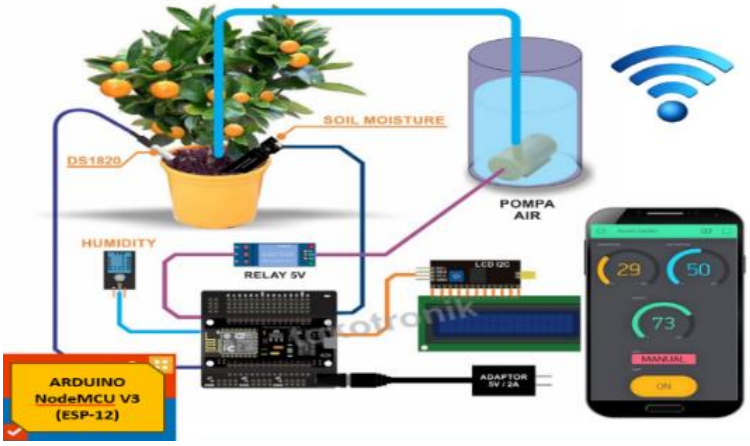

Figure 2 Arduino-based smart garden STEM project

METHODS

This community service uses a Participatory Action Research (PAR) approach to empower teachers to integrate STEM in learning. The implementation of community service activities entitled Integrating Environmental STEM Training By Wetland Local Potential to Improve Environmental Literacy of Science Teachers in Banjarmasin is divided into three main stages: preparation, implementation, and evaluation.

Preparation Stage

At this stage, the activity began with preparing a training program based on discussions with the Natural Science Subject Teachers' Association Community of Banjarmasin. This discussion aims to identify the problems teachers face in teaching environmental literacy and explore relevant local potentials to be used as teaching materials. The Community Services team then prepared training strategies and techniques to answer these needs, which are socialized to Natural Science Subject Teachers' Association partners. This socialization included an explanation of the training schedule and techniques so that all parties involved had the same understanding regarding the objectives and processes of the activity.

Implementation Stage

The implementation stage consists of several steps as follows:

1. Making a STEM Learning Design Integrated with the Local Potential of Wetlands
   This step includes several stages: a). The Community Services team analyzed the learning difficulties in schools. After the analysis, it turned out that the difficulties lay in the learning methods used, so the solution to this problem is to design STEM-based learning, which is poured into the form of learning modules. The stages in STEM-based learning were problem-oriented. The problem still widely found in wetland areas is the lack of clean water. Therefore, in the second stage, designing the manufacture of water filters; c) Implementing the design for making IoT-based water filters. d) Evaluating the response or feedback from teachers after participating in this training.
2. IoT-Based STEM Learning Development Practices Using Arduino Modules and Blynk Applications
   After theoretical training, the teachers conducted direct practice of IoT-based learning development using Arduino Modules and Blynk Applications. One of the main practices was creating an automatic plant watering tool that can be controlled via the internet. Through this practice, the teachers learned how to do simple programming with Arduino, which was then connected to the Blynk application to control the tool remotely. This experience provided new insights for teachers on how IoT technology can be integrated into problem-based science learning, while introducing technology concepts to students.

RESULTS AND DISCUSSION

The implementation of the Integrating Environmental STEM by Wetland Local Potential Training to Improve Environmental Literacy of Science Teachers in Banjarmasin has positively impacted environmental literacy and teacher competence in integrating STEM-based learning that is relevant to the local potential of wetlands. Banjarmasin, known as the city of "A Thousand Rivers," has rich local potential in the form of wetlands, and this is optimized in science learning through the integration of the STEM (Science, Technology, Engineering, and Mathematics) approach.

Strengthening Environmental Literacy through Wetland Potential

One of the main objectives of this training is to improve teachers' environmental literacy by utilizing local potential. The potential of wetlands, such as swamp ecosystems and mangrove forests, is not only the focus of science learning but is also an important topic in the discussion of environmental literacy. Based on the training results, science teachers in Banjarmasin gained a deep understanding of how to utilize wetland ecosystems as relevant and contextual teaching materials for students.

Research shows that local potential-based learning not only helps students understand scientific concepts better but also increases student engagement in local environmental issues (Handiyati et al., 2023). Integrating wetland potential with STEM learning allows students to learn more practically and meaningfully, increasing their environmental awareness. Environmental literacy built through this approach is very important to form a generation that cares and is aware of the importance of nature conservation.

Improving the understanding of STEM learning for science teachers

One of the innovations implemented in this training is the introduction of IoT (Internet of Things) technology in STEM learning. Teachers are trained to use the Arduino Module and Blynk Application, which allows them to develop simple automation tools such as automatic plant waterers (Figure 3). The use of this technology not only supports the STEM learning process but also provides teachers with practical experience in integrating modern technology into science learning.

Figure 3 The teachers were trained to use the Arduino Module and Blynk Application

Research has shown that the integration of IoT technology in STEM education helps improve students' critical thinking, creativity, and problem-solving skills (Davidi et al., 2021). In this training, teachers are trained to program IoT devices using Arduino and connect the devices with the Blynk application to control the tools remotely. This practice opens up new insights for teachers on how technology can be applied in solving real problems, especially in local environmental issues such as wetland management (Weningtyas & Widuri, 2022). Thus, the STEM approach and IoT technology positively impact students' understanding of science and technology. This integration also motivates students to be more interested in science and technology because they can see how their knowledge can be applied in real life (Nurjanah et al., 2023).

Based on a survey conducted at partner schools after the training, the results showed a significant increase in teachers' pedagogical competence in creating a more dynamic and interactive learning environment (Figure 4). The average satisfaction score of participants reached 4.31 out of 5, indicating that this training was very effective in improving teachers' understanding of IoT-based STEM learning and local potential (Busyairi et al., 2022). In particular, teachers gave high appreciation to the introduction of IoT technology, with a score of 4.50, and they felt that this approach was very relevant to support innovative learning in the classroom (Setiawan et al., 2020).

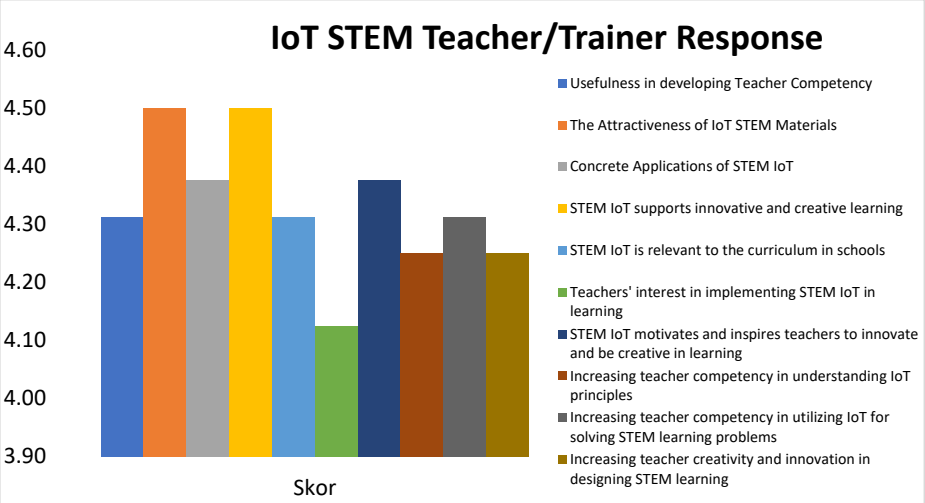

Figure 4 The participant responses to IoT STEM training

Previous studies have also shown that developing teacher competencies through modern technology-based training can increase student engagement in learning (Prasetyo et al., 2023). Teachers who have skills in using IoT technology in STEM learning can create a more dynamic and interactive learning environment. This provides students with the opportunity to learn relevant technology and develop 21st-century skills such as critical thinking, collaboration, and creativity (Syahmani, Iriani, et al., 2023).

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1. Improving teacher competence in creating a more dynamic and interactive learning

This training also provides teachers with insight into the importance of program sustainability. One of the discussions that emerged in the training evaluation was how this program could be continued to other schools in the Banjarmasin area and its surroundings. Teachers proposed that this program be expanded and continued by introducing more innovative technologies in learning, such as the use of real-time data through IoT-based environmental sensors (Syahmani et al., 2022).

Regarding sustainability, this training also discussed the potential for patent registration for tools developed during the training, such as automatic plant watering tools. With patents, innovations developed by these teachers can be legally registered and recognized as their contribution to the development of technology-based education (Sholahuddin et al., 2022). According to research, the sustainability of STEM and IoT-based training programs is very important to advance contextual and technology-based education in Indonesia (Kusasi et al., 2021).

This training has a long-term impact on student learning. With teachers who are more competent in teaching technology-based STEM and local potential, students are expected to be able to learn more effectively and contextually (Figure 5). Environmental literacy instilled through this approach not only strengthened students' understanding of scientific concepts but also fostered a sense of responsibility for environmental preservation (Syahmani et al., 2021).

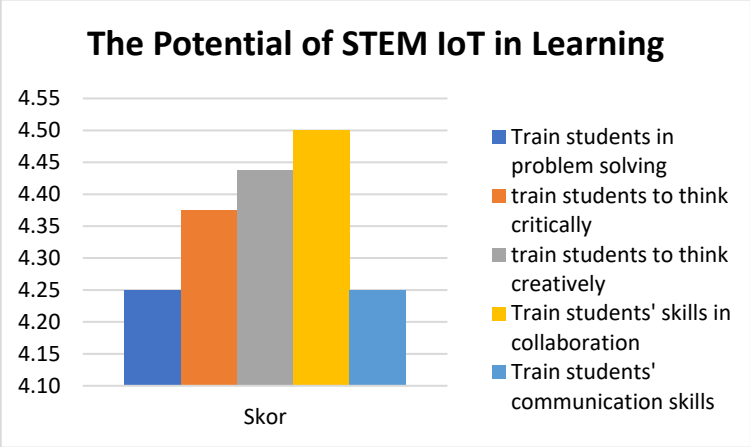

Figure 5 The potential of STEM IoT in learning

Applying IoT technology in learning also prepares students to face global challenges such as climate change and environmental degradation. By learning through technology-based projects, students can develop relevant skills to solve real problems in their environment (Ediana et al., 2023). According to research, this approach also helps prepare students for careers in STEM, which are in great demand in this digital era (Muttaqiin, 2023).

CONCLUSION

Participants responded positively to Integrating Environmental STEM Training by Wetland Local Potential because it improved teachers' understanding of IoT-based STEM learning and local potential. The average satisfaction score of participants reached 4.31. Teachers who have skills in using IoT technology in STEM learning can create a more dynamic and interactive learning environment.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

Conceptualization: AW & YDP; methodology: AW, YDP & RI; data collection and tabulation: PS, AIR & IB; formal analysis: AW, MK & YDP; writing—preparing the original draft: AIR & YDP.

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