

EDUBIMA BASED ON *AUGMENTED REALITY*: DEVELOPMENT OF DISASTER MITIGATION AND ENVIRONMENTAL MANAGEMENT LEARNING

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ABSTRACT

This community service program aims to improve disaster preparedness and environmental management skills among students and educators at Muhammadiyah Boarding School (MBS) An-Nur Sidoarjo through the development of EDUBIMA learning media based on Augmented Reality (AR). The background for this activity is the high vulnerability of the Sidoarjo region to disasters and the low level of disaster knowledge and preparedness in the pesantren environment. The implementation methods include the development of AR learning media, interactive education, disaster response simulations, and evaluation using pre-tests and post-tests. The results showed a significant increase in disaster mitigation knowledge, from a low category of 56% to a high category of 70% after the intervention. This activity concludes that the use of AR-based EDUBIMA is effective in increasing disaster literacy and encouraging better environmental management behavior in the pesantren environment.

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INTRODUCTION

The partner targeted by this Community Partnership Program is Muhammadiyah Boarding School (MBS) An-Nur, located at Jl. H. Ahmad Dahlan No. 1, RT 03, RW.01, Pentarsewu Village, Tanggulangin District, Sidoarjo Regency. MBS An-Nur is a boarding school that implements a modern Islamic education system with an integrated curriculum. The location of MBS An-Nur is quite strategic, but it also has its own challenges, especially related to the potential for environmental disasters due to the geographical conditions of the Sidoarjo area, which is prone to flooding, such as the area affected by the Lapindo mudflow and the impact of surrounding industries. At MBS An-Nur Sidoarjo, there are 70 students, consisting of 39 male students and 31 female students.



Figure 1. Front view of the school

MBS An-Nur Sidoarjo, as an Islamic boarding school-based educational institution, plays a very important role in addressing environmental issues in the surrounding area. Therefore, cooperation with various parties is possible by creating an easily accessible social network. To that end, MBS An-Nur Sidoarjo has the potential to partner with organizations, government, and communities engaged in education, social, and health fields to build a healthy environment, thereby improving welfare and optimizing public health. The MBS An-Nur Sidoarjo area is closely associated with threatening events, such as floods, earthquake risks, and the impact of the Lapindo mudflow, which still affects soil conditions and the ecosystem (Alisjahbana & Murniningtyas, 2021).



Figure 2. Conditions inside the Muhammadiyah Boarding School (MBS) An-Nur
This community service was motivated by Indonesia being classified as one of the

countries with a high risk of natural disasters and disasters caused by human activities. Based on the World Risk Report (WRR) research in 2024, Indonesia is ranked as the country with the second highest risk of natural disasters in the world (Cross, 2024). This high level of risk is due to Indonesia's geographical location in the Pacific Ring of Fire, where active tectonic plates meet, earning Indonesia the nickname Ring of Fire. In addition, Indonesia is also a tropical country with high rainfall, which has the potential to cause flooding. Based on preliminary analysis, there are seven cities in Indonesia that are included in the 136 priority locations for Disaster Risk Reduction (DRR) in the 2015- 2019 Medium-Term Development Plan (RPJMN), and are also included in the category of 50 (fifty) regions vulnerable to climate change in the 2014 National Action Plan for Climate Change Adaptation (RAN-API). These areas are in the district of Sidoarjo (Ruang, 2021). According to the National Disaster Management Agency (BNPB), the disaster risk index for Sidoarjo Regency in 2020 is in the moderate category with a score of 78.89. However, the Sidoarjo Regency Government remains vigilant about the possibility of disasters occurring in Sidoarjo. The results of the 2018 Sidoarjo Regency Disaster Risk Assessment identified seven risks. disasters, four of which are at high risk, including in the Tanggulangin subdistrict (Asiva Noor Rachmayani, 2021).

On the other hand, Sidoarjo Regency, as one of the regencies in East Java, also has problems related to waste and environmental management. Until 2021, the amount of waste produced by the people of Sidoarjo Regency reached around 4,700 tons per day, while the capacity to transport waste to the landfill was only around 25%. Thus, approximately 3,500 tons of waste per day cannot be transported. It is possible that this uncollected waste is managed by the community in a manner that does not comply with environmental procedures, for example, by being dumped into rivers, burned, buried in holes in the ground, and so on, especially in Pentarsewu Village (Rahmayanti et al., 2022).

Based on observations and interviews with one of the educators at MBS An-Nur Sidoarjo, it was found that most of the Islamic boarding school staff, both teachers and students, still do not know how to mitigate disasters and manage the environment and health. This is influenced by the level of disaster preparedness in Indonesia, which is still weak. Meanwhile, preparedness is the most strategic stage in disaster management because it determines resilience in facing disasters. From the interview results, there are four problems currently faced by MBS An-Nur Sidoarjo.

First, disaster preparedness among students and boarding school administrators is still minimal. This is due to a lack of knowledge about evacuation procedures during disasters such as earthquakes, fires, and floods. Second, there are no learning materials that support disaster preparedness and mitigation at MBS An-Nur Sidoarjo. This is an urgent issue for MBS An-Nur Sidoarjo, as it affects the well-being of teachers and students, who often feel worried, anxious, and fearful of the threat of disasters.

Third, understanding and skills in environmental management are still very limited. Many students and educators have not received training in handling injuries, wounds, or other medical emergencies. Fourth, environmental and health management in Islamic boarding schools is still not optimal. Organic and inorganic waste is not managed properly, which has the potential to cause environmental pollution. In addition, the low awareness of students and educators regarding the importance of environmental sanitation and the implementation of clean and healthy living behaviors (PHBS) is also a challenge in creating a healthier and more comfortable environment for learning.

Based on these issues, this community service program aims to improve disaster preparedness at MBS An-Nur Sidoarjo through Augmented Reality-Based Interactive Disaster Mitigation Education (EDUBIMA). Additionally, this program is designed to improve the environmental management skills of students and educators, so that they have the basic skills to handle emergency situations, and also to encourage awareness and practices of healthy environmental management to create a cleaner and safer Islamic boarding school environment.

This program is in line with several Sustainable Development Goals (SDGs), including SDG 3, which is good health and well-being, focusing on improving environmental management and health skills, SDG 4, which is quality education that provides education on disaster preparedness and digital technology-based environmental management, and SDG 11, which is sustainable cities and communities that educate the public about disaster mitigation in disaster-prone areas (Alisjahbana & Murniningtyas, 2021). In addition, this program supports the achievement of Key Performance Indicator (IKU) 2, which is to provide students with learning experiences outside the campus through community service programs, and IKU 3, which is for lecturers to participate in activities outside the campus with partners through disaster preparedness and environmental management training (Nurhasanah et al., 2024). This program is also in line with the Fourth Asta Cita, which is to strengthen the culture of research and innovation in solving problems, especially in the fields of disaster mitigation and health. Within the context of the National Research Master Plan (RIRN), this program falls under the focus areas of Health and Disaster Management, where the development of a technology-based educational model serves as the primary solution to enhance disaster preparedness and environmental management skills among students and educators at MBS An-Nur.

RESEARCH METHOD

This community service activity uses the Participatory Learning and Action (PLA) approach through the following systematic stages:

1. Preparation Stage
This stage includes field observations, problem identification, partner needs analysis, and the development of digital learning instruments based on Augmented Reality (AR). At this stage, the team coordinated with MBS An-Nur to determine the types of disaster mitigation and environmental management materials that were relevant.
2. Development of AR-Based EDUBIMA Media
The learning media was developed by combining 3D visualization, interactive simulations, and disaster mitigation scenarios contextualized to the pesantren environment. This process included

storyboard creation, content integration, and internal testing by the development team.

3. Implementation of Education and Simulation

Educational activities were carried out through training, delivery of material using AR applications, and emergency response practice simulations. Students and educators were actively involved in discussions and question and answer sessions. Assistance was provided by a team of volunteers and student volunteers.

4. Program Evaluation

Evaluation is conducted using pre-tests and post-tests to measure changes in knowledge related to disaster mitigation and environmental management. Data is analyzed descriptively to see improvements in scores and the distribution of knowledge categories.

5. Reflection and Follow-up

The team and partners conducted reflections to assess the program's effectiveness, the sustainability of media use, and plans for further implementation in the pesantren curriculum.

RESULTS

Disaster Mitigation Knowledge

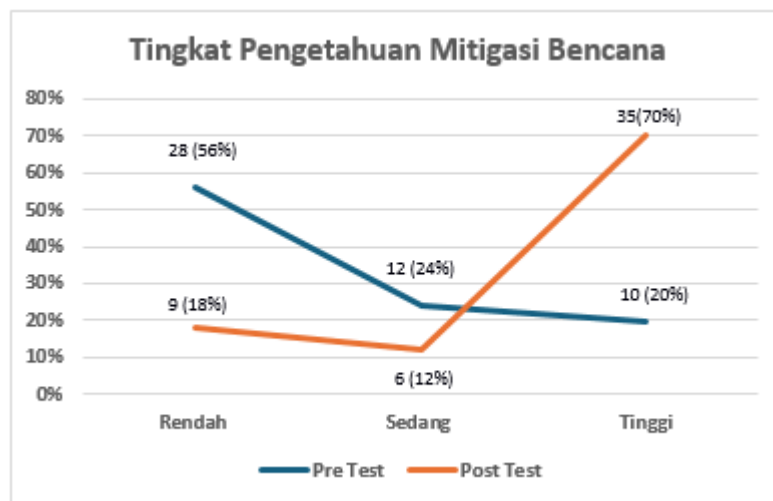


Figure 4. Graph of Disaster Mitigation Knowledge Level

Based on Figure 4, before the intervention (pre-test), most participants were in the low knowledge category, namely 28 respondents (56%), while participants with moderate knowledge numbered 12 respondents (24%), and those with high knowledge numbered only 10 respondents (20%). These results indicate that at the beginning of the activity, most students and partner teachers did not have adequate understanding of disaster mitigation measures, evacuation procedures, and risk prevention efforts in the school environment. After the implementation of the community service program through the use of the Augmented Reality-based EDUBIMA application, the post-test results showed a significant change in the distribution of knowledge levels. The number of participants in the high knowledge category increased to 35 respondents (70%), while the moderate category numbered 12 respondents (24%), and the low category decreased dramatically to 6 respondents (12%). This increase illustrates the effectiveness of technology-based learning media in helping participants understand disaster mitigation material interactively and contextually.

Several factors influenced the participants' increased knowledge. First, the use of Augmented Reality-based disaster simulation visualization features in the EDUBIMA application helped participants gain a realistic picture of disaster situations and the emergency response measures that must be taken. Second, the learning method, which combined audiovisual explanations and educational games, was able to attract the students' interest in learning, thereby deepening their understanding. Third, direct assistance from the volunteer team and student volunteers allows participants to actively interact in simulation and discussion sessions.

The results of the analysis show that the application of AR-based digital technology has a positive impact on improving disaster literacy. An average increase in knowledge of more than 20% proves that interactive learning such as EDUBIMA can be an effective strategy in educating students about disaster preparedness. In addition, these results also reinforce the role of schools as centers of disaster education that not only focus on theory but also emphasize practical understanding through virtual and simulated learning experiences. Thus, it can be concluded that the use of EDUBIMA media significantly increases the knowledge of students and teachers regarding disaster mitigation, both in terms of basic concepts, risk identification, and emergency response actions. These results serve as empirical evidence that the integration of technology in disaster mitigation learning can create positive behavioral changes and increase preparedness in the pesantren educational environment.



Gambar 5. Penerapan EDUBIMA Berbasis Ar

DISCUSSION

The results of the activity show that the use of EDUBIMA learning media based on Augmented Reality (AR) has a significant impact on improving disaster literacy and environmental management among students and educators at MBS An-Nur Sidoarjo. The increase in knowledge from low to high after the intervention indicates that AR technology is able to provide a more immersive learning experience compared to conventional methods. 3D visualizations and interactive simulations helped participants understand disaster scenarios more concretely, thereby improving their ability to identify risks and take appropriate emergency response measures. In addition, AR-based learning has been proven to increase participants' motivation to learn. The combination of visual media, audio, and digital interaction makes the educational process more interesting and easier to understand, especially for teenagers in Islamic boarding schools who previously did not have adequate access to disaster training. This is in line with previous studies which state that the use of digital technology, including AR and VR, can increase knowledge retention and disaster preparedness among students.

The results of this activity also show that the integration of disaster education with environmental management has a positive impact on participants' behavioral change. Discussions, simulation practices, and mentoring have made students better understand the importance of protecting the environment as part of disaster mitigation. Thus, this program not only improves cognitive aspects but also encourages environmentally conscious behavior. These findings confirm that AR-based EDUBIMA can be an effective, applicable, and sustainable disaster education model. Its implementation can be expanded to other schools or Islamic boarding schools by adjusting the content to the geographical conditions and disaster risks of each region.

CONCLUSION

The community service program through the application of AR-based EDUBIMA has proven to be effective in increasing disaster knowledge and preparedness among students and educators at MBS An-Nur Sidoarjo. AR learning media provides an interactive, engaging, and contextual learning experience that improves participants' understanding of emergency response and environmental management. Evaluation using pre-tests and post-tests showed a significant increase from low to high knowledge categories. Thus, EDUBIMA has the potential to be further developed as yang inovatif dan berkelanjutan di lingkungan pendidikan pesantren maupun sekolah lainnya.

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