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Electronics training using microcontroller at MA Ihyaul Islam Bolo

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Abstract
This community service was conducted at Madrasah Aliyah Ihyaul Islam Bolo, Gresik, a school with the potential to develop skilled human resources in the industrial sector. This activity aimed to enhance students' knowledge and skills about the Internet of Things (IoT) technology for automatic control. The implementation method involved electronics training using the Arduino Uno microcontroller, including material presentation, demonstrations, case studies, and hands-on practice. A total of 20 twelfth-grade students participated in this training. The results achieved demonstrate an increase in students' understanding of the training material. Based on questionnaires completed after the training, 44% of students stated a good understanding of the material provided. In addition, there was a strong positive correlation (0.9) between students' assessment of the quality of the material and the completeness of the training material. This activity made a significant contribution to improving the competence of students and teachers related to IoT technology, as well as opening up opportunities for collaboration between schools, universities, and industry.

Keywords: IoT; Electronics; Microcontroller; Skill

Contributions to SDGs

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Pelatihan elektronika dengan microcontroller di MA Ihyaul Islam Bolo

Abstrak
Pengabdian kepada masyarakat ini dilaksanakan di Madrasah Aliyah Ihyaul Islam Bolo, Gresik, sebuah sekolah yang berpotensi mengembangkan sumber daya manusia terampil di bidang industri. Kegiatan ini bertujuan untuk meningkatkan pengetahuan dan keterampilan siswa tentang teknologi Internet of Things (IoT) untuk kontrol otomatis. Metode pelaksanaan melibatkan pelatihan elektronika menggunakan mikrokontroler Arduino Uno yang meliputi presentasi materi, demonstrasi, studi kasus, dan praktik langsung. Sebanyak 20 siswa kelas XII berpartisipasi dalam pelatihan ini. Hasil yang dicapai menunjukkan peningkatan pemahaman siswa terhadap materi pelatihan. Berdasarkan kuesioner yang diisi setelah pelatihan, 44% siswa menyatakan pemahaman yang baik terhadap materi yang diberikan. Selain itu, terdapat korelasi positif yang kuat (0,9) antara penilaian siswa terhadap kualitas materi dan kelengkapan materi pelatihan. Kegiatan ini memberikan kontribusi signifikan dalam meningkatkan kompetensi siswa dan guru terkait teknologi IoT, serta membuka peluang kolaborasi antara sekolah, universitas, dan industri.

Kata Kunci: *IoT; Elektronika; Mikrokontroller; Skill*

1. Introduction

As an industrial city, Gresik has numerous factories that require skilled labor. In the era of the Fourth Industrial Revolution, expertise is increasingly competitive, particularly with the establishment of the ASEAN Economic Community (AEC) in 2015. This agreement allows for the unrestricted flow of goods, services, capital, investment, and skilled labor among member countries, including Indonesia (Merdeka.com, 2020). Consequently, improving the quality of Indonesia's human resources through vocational education is crucial to facing these challenges (Qasim et al., 2021; Saraswat et al., 2024).

The Electrical Engineering program at Universitas Muhammadiyah Gresik has conducted several community service initiatives to address this need. These activities have included training programs at SMK Mambaul Ulum in 2021 (Puji et al., 2021) and SMK Muhammadiyah 1 Gresik in 2022 (Astutik et al., 2022). In 2023, workshops on PLC-SCADA Outseal Haiwell were held at SMK Semen Gresik (Astutik et al., 2023) and SMK Negeri 1 Singosari (Irawan et al., 2023). Furthermore, a significant body of research from the university has explored IoT technology, from machine-to-machine communication to its practical applications in various fields (Rholam et al., 2019). Examples include monitoring water and fertilizer in milkfish ponds (Firmansyah & Astutik, 2024), monitoring heartbeats (Astutik & Bakti, 2020), designing smart mousetraps (Bakti et al., 2022), and monitoring mint plants (Putra & Astutik, 2024).

Madrasah Aliyah (MA) Ihyaul Islam Bolo, located in the Ujung Pangkah District of Gresik, is one of the schools that aims to produce skilled human resources for local industries. This school has significant potential for development through collaboration with nearby companies and universities that can provide specialized training. Equipping students with vocational and technopreneurship skills will benefit both the students' future careers and the school's long-term development. Upskilling students and teachers is vital for enhancing a school's reputation and branding (Milana et al., 2025).

A situational analysis at MA Ihyaul Islam Bolo, located at Jl. Strada No.2, Bolo, Ujungpangkah District, revealed that students' knowledge of IoT technology is limited due to the school's focus on religious education. This knowledge gap presents an opportunity for a community service program to increase students' exposure to and understanding of technology. IoT technology is instrumental in transforming education into a smarter learning environment (Meylani, 2024) and has been a subject of great interest in higher education, particularly for e-learning platforms during the pandemic (Ghashim & Arshad, 2023; Kumar & Al-Besher, 2022; Yakoubovsky & Sarian, 2021).

This community service project aims to address this need by introducing students to IoT technology for automatic control. The training will focus on using the Arduino Uno microcontroller, involving students directly in programming and module testing (Bhatnagar, 2024; Yamao & Lescano, 2020). After the training, several real-life case studies will be presented to help students visualize and apply the concepts they have learned (Shaikh et al., 2019; Sonsilphong et al., 2022). As rural students often have fewer opportunities than their urban counterparts (Susanta et al., 2025), this program is an ideal way to help MA Ihyaul Islam Bolo students develop essential technological skills.

2. Method

The community service initiative was initiated with an outreach to MA Ihyaul Islam Bolo, Gresik, to introduce the training program and finalize the schedule. Prior to the training session, the team visited the school to install the necessary software on the students' laptops. The training was conducted on Wednesday, April 9, 2025, from 8:00 AM until completion. The session took place at the school, located at Jl. Strada No.2, Bolo, Kec. Ujungpangkah, Kabupaten Gresik, Jawa Timur 61154, and involved 20 students from Class XII.

The implementation method was designed to prepare students for the challenges of an automated work environment and to provide a foundation for those interested in pursuing engineering studies. The approach began with a lecture-based introduction, followed by hands-on training using the Arduino Uno microcontroller and its operation. To reinforce learning, students were given the opportunity to simulate and execute a provided case study. This approach, which integrates introductory lectures with practical application, is consistent with various methods used in IoT technology education (Badshah et al., 2023; Mircea et al., 2021; Tutkyshbayeva & Zakirova, 2024).

3. Results and Discussion

3.1. Electronics training using microcontroller

Prior to the implementation, lecturers from the Electrical Engineering program provided a briefing to the student team. This session was designed to align their perceptions and ensure a focused and coordinated delivery of the material. The training began with an introduction to microcontrollers, as the students at MA Ihyaul Islam Bolo, Gresik, had no prior knowledge of them. This introductory session covered the basic functions of each component of the microcontroller, followed by an overview of its programming language, as shown in Figure 1. Developing an understanding of programming languages is a crucial skill for students, particularly for future system analysis (Lin et al., 2025).

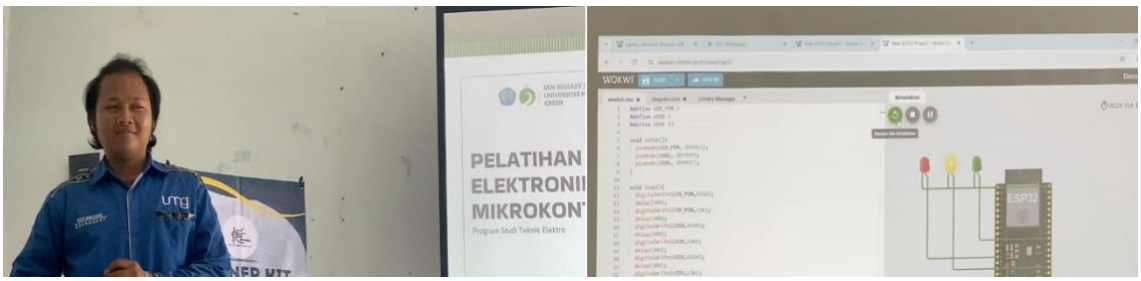

Figure 1. Introducing to microcontroller and programming

Due to limited laptops, students were divided into groups to collaboratively work on a simple case study program. Electrical Engineering students from the university were actively involved in assisting each group, helping them troubleshoot any issues with their laptops or code. After successfully completing the simple case study, students were given a more complex challenge to implement on a trainer kit. This approach of hands-on, case-based learning is a well-established method for technology education, similar

to studies on air pollution monitoring in the Gresik area (Misbah et al., 2018). Figure 2 documents the IoT workshop at MA Ihyaul Islam Bolo, Gresik.

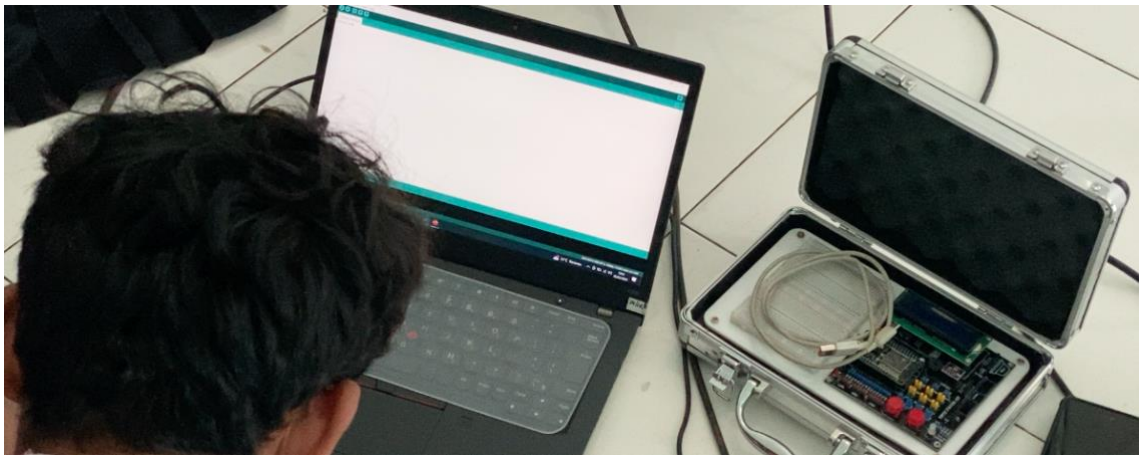

Figure 2. Implementation of programming on the provided trainer kit

3.2. Evaluation

Upon completion of the case study and material presentation, students were asked to complete a questionnaire to evaluate the workshop. The questionnaire assessed several key statements: a) quality of the material provided, b) understanding of the material provided, c) clarity of the speaker in delivering the material, and d) completeness of equipment.

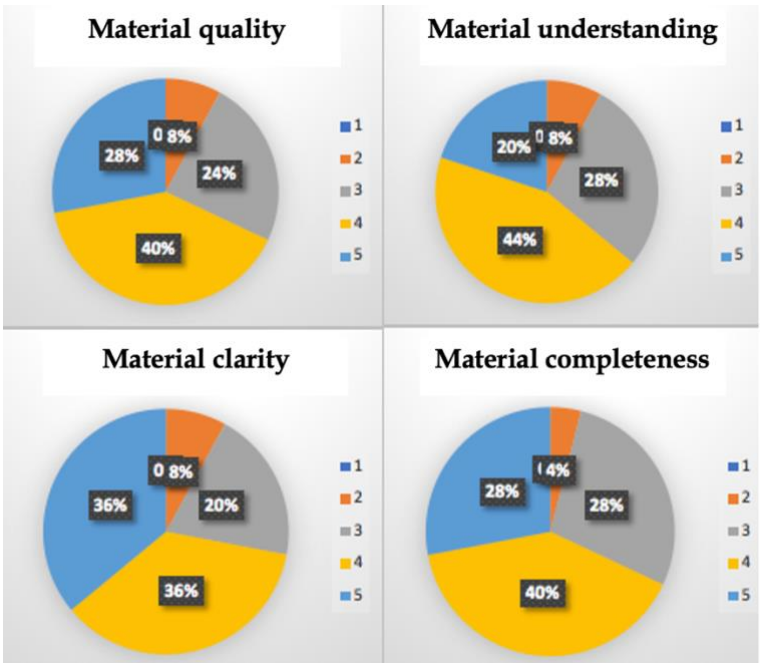

Figure 3. Percentage of student assessment on understanding of training material

The questionnaire data provided insights into the students' comprehension, as shown in Figure 3 and Figure 4. Figure 3 illustrates the percentage of student evaluations for each question. The results show that student perceptions were overwhelmingly positive. Notably, the question regarding "Material Understanding" received the highest positive

rating, with 44% of students rating it as "Excellent." This indicates that a significant portion of the participants effectively grasped the provided material.

The correlation between different aspects of the training was analyzed and is presented in Figure 4. The graph reveals a strong positive correlation (0.9) between the "Quality of the material" and the "Completeness of the material," suggesting that students who rated the material's quality highly also perceived it as complete. Similarly, the "Clarity of the presenter" showed a high correlation with other aspects, highlighting the significant impact of the instructor's delivery style on the overall perceived quality and understanding. The community service concluded with a final group photo with the participants, commemorating the successful completion of the training.

Figure 5. Correlation between assessment aspect

4. Conclusion

A series of community service activities, in the form of an Electronics Training with Microcontrollers workshop, was successfully implemented at Madrasah Aliyah Ihyaul Islam, Bolo, Gresik. Based on observations made during the training and the results of the student questionnaires, it can be concluded that this program is highly beneficial for enhancing students' competencies and assisting teachers in broadening their understanding of IoT technology.

The questionnaire results indicate a high level of student comprehension, with the evaluation for "Material Understanding" reaching a positive rating of 44%. Furthermore, the analysis of correlations between different aspects of the training revealed a strong positive relationship. A correlation value of 0.9 was found between "Material Quality" and "Material Completeness," suggesting that students who perceived the quality of the material as high also tended to rate its completeness highly.

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Author Contribution

Activity implementation: RPA, AAM, BG, KK; Article preparation: RPA, AAM; Analysis of service impact: AAM, BG; Presentation of service results: AAM, BG, KK; Article revision: RPA.

Conflict of Interest

The authors state that there is no conflict of interest in the publication of this article.

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