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Project-Based Learning in Microprocessor Systems Courses Through the Development of an Arduino-Based Automatic Garden Lighting System

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ABSTRACT

This study aims to describe the implementation of Project-Based Learning (PjBL) in the Microprocessor Systems course through the development of an Arduino Uno-based automatic garden lighting system. The project was designed to provide students with practical experience in integrating microcontroller systems, light sensors, programming, and electrical control components into a functional application. The learning activities consisted of project planning, component identification, circuit design, hardware assembly, programming, system testing, troubleshooting, and project presentation. The system utilized an Arduino Uno as the main controller, a BH1750 digital light intensity sensor as the input device, and a relay module to control the garden lighting load. Data were collected through observation, project assessment, functional testing, and documentation of student activities. The assessment focused on students' abilities in circuit assembly, sensor integration, programming, system functionality, troubleshooting, teamwork, and presentation. The results showed that students were able to apply microprocessor concepts to a real-world automation problem. The project also encouraged active participation, problem-solving, critical thinking, collaboration, and technical communication. The implementation of PjBL through an automatic garden lighting project can therefore be considered an appropriate learning strategy for developing practical competencies in Microprocessor Systems courses..

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INTRODUCTION

The development of microcontroller and embedded system technology has resulted in significant changes in the field of computer technology and automation. Microcontrollers are increasingly applied in various systems, including lighting control, environmental monitoring, home automation, industrial control, and Internet of Things applications. Therefore, students in Computer Technology programs need not only to understand the theoretical concepts of microprocessors and microcontrollers but also to possess practical competencies in designing, programming, testing, and troubleshooting electronic systems.

Microprocessor Systems courses are an important part of computer technology education because they introduce students to the relationship between hardware and software. Through these courses, students are expected to understand microcontroller architecture, input and output systems, sensor interfacing, programming, and the implementation of microprocessor-based control systems. However, theoretical learning alone may not provide sufficient experience for students to understand how these concepts are applied in real situations.

One of the learning approaches that can connect theoretical knowledge with practical applications is Project-Based Learning (PjBL). PjBL provides students with opportunities to learn through the process of designing and completing a project. Students are encouraged to identify problems, develop solutions, implement their ideas, test the resulting system, and communicate the project outcomes. Kokotsaki, Menzies, and Wiggins (2016) explain that Project-Based Learning is a student-centered learning approach that involves active investigation and the production of a meaningful product or outcome.

The application of PjBL in microprocessor-related courses is particularly relevant because microcontroller projects require the integration of several competencies simultaneously. Students need to understand electronic components, construct circuits, write programs, analyze system responses, identify errors, and work collaboratively. Previous research has shown that Project-Based Learning can support the improvement of student learning outcomes and competencies in higher education. Fatimah et al. (2024), for example, reported the implementation of Project-Based Learning to improve student competencies. Research related to Microprocessor Systems courses has also indicated the relevance of PjBL as a learning model for improving student learning outcomes.

An example of a simple but applicable microcontroller project is an automatic garden lighting system. Garden lighting generally requires manual operation or a predetermined time schedule. An automatic system can instead utilize environmental light intensity as the basis for controlling the lighting. During periods of sufficient illumination, the lamp can remain off, while during low-light conditions, the lamp can be activated automatically.

The BH1750 sensor is suitable for this application because it can measure ambient light intensity digitally in units of lux. The sensor communicates with the Arduino Uno through the I2C interface, making it appropriate for introducing students to sensor interfacing and digital communication. The measured light intensity can then be processed by the Arduino Uno to determine the activation status of a relay module connected to the lighting load.

The development of an automatic garden lighting system therefore provides an integrated learning activity. Students are required to design the circuit, connect the sensor, program the Arduino Uno, configure the control logic, test the system, and solve problems

encountered during implementation. These activities are consistent with the characteristics of Project-Based Learning because students are involved directly in the process of producing a functional technological product.

Based on this background, this study aims to describe the implementation of Project-Based Learning in the Microprocessor Systems course through the development of an Arduino Uno-based automatic garden lighting system. The study also examines the learning activities and competencies developed through the project, particularly in hardware assembly, programming, sensor integration, system testing, troubleshooting, teamwork, and presentation.

METHODS

1. Research Desaign

This study employed a descriptive approach to describe the implementation of Project-Based Learning in the Microprocessor Systems course. The learning activity was organized around the development of an Arduino Uno-based automatic garden lighting system. The PjBL process was implemented through several stages: project planning, system design, hardware assembly, programming, testing, troubleshooting, and project presentation. The project was designed to allow students to apply theoretical concepts obtained during the Microprocessor Systems course to a practical automation problem.

2. Project Development

The automatic garden lighting system consisted of several main components, including Arduino Uno, BH1750 light intensity sensor, relay module, LED lamp, breadboard, jumper wires, and a power supply.

The Arduino Uno functioned as the central controller. The BH1750 sensor was used to detect the surrounding light intensity. The sensor transmitted the measured lux value to the Arduino Uno through the I2C communication interface. The Arduino then compared the sensor reading with a predetermined threshold value.

When the measured light intensity was below the threshold, the Arduino activated the relay so that the garden lamp was switched on. Conversely, when the measured light intensity was above the threshold, the relay was deactivated and the lamp was switched off.

The general system operation can be described as follows:

BH1750 Sensor → Arduino Uno → Control Program → Relay Module → Garden Lamp

3. Project-Based Learning Activities

The learning activities were organized into the following stages.

1. Project Planning

Students were introduced to the problem of controlling garden lighting automatically. They identified the required components and discussed the basic operating principle of an automatic lighting system.

2. System Design

Students developed the circuit design and determined the connection between the BH1750 sensor, Arduino Uno, relay module, and lamp. At this stage, students also determined the control logic based on the light intensity threshold.

3. Hardware Assembly

Students assembled the components according to the circuit design. Particular attention was given to power connections, I2C communication lines, relay input connections, and output connections.

4. Programming

Students developed an Arduino program to read the BH1750 sensor and control the relay. The program included sensor initialization, light intensity measurement, threshold comparison, and relay control.

5. System Testing

The assembled system was tested under different lighting conditions. Students observed the sensor readings and the response of the lamp. The test results were recorded and analyzed.

6. Troubleshooting

If the system did not operate correctly, students were required to identify the source of the problem. Possible problems included incorrect wiring, programming errors, sensor communication problems, or relay configuration errors.

7. Presentation

Each student or group presented the completed project, explained the working principle, demonstrated the system, and discussed the problems encountered during development.

4. Data Collection

Data were collected using observation, project assessment, functional testing, and documentation. Observation was used to record student participation during project implementation. Project assessment was used to evaluate technical and non-technical competencies. Functional testing was conducted to determine whether the automatic lighting system operated according to the designed control logic. Documentation was used to record the project development process and final system.

RESULTS AND DISCUSSION

1. Project Implementation

The implementation of the automatic garden lighting project provided students with direct experience in applying microprocessor concepts. At the beginning of the activity, students identified the problem and determined the system requirements. They then selected the appropriate components and developed the initial circuit design.

The use of Arduino Uno allowed students to focus on the relationship between sensor input, processing, and actuator output. The BH1750 sensor provided a measurable digital input, while the relay acted as the switching component for the lighting system.

The project also introduced students to the concept of automation. Instead of manually controlling the lamp, the system responded automatically to changes in environmental light intensity.

2. Hardware Assembly

During hardware assembly, students connected the BH1750 sensor to the Arduino Uno using the I2C interface. The sensor was configured as the input component, while the relay module was connected to a digital output pin.

The hardware assembly stage provided an opportunity for students to understand the importance of correct wiring. Incorrect power connections, loose jumper wires, and incorrect pin assignments were among the potential problems that students had to identify during the practical activity.

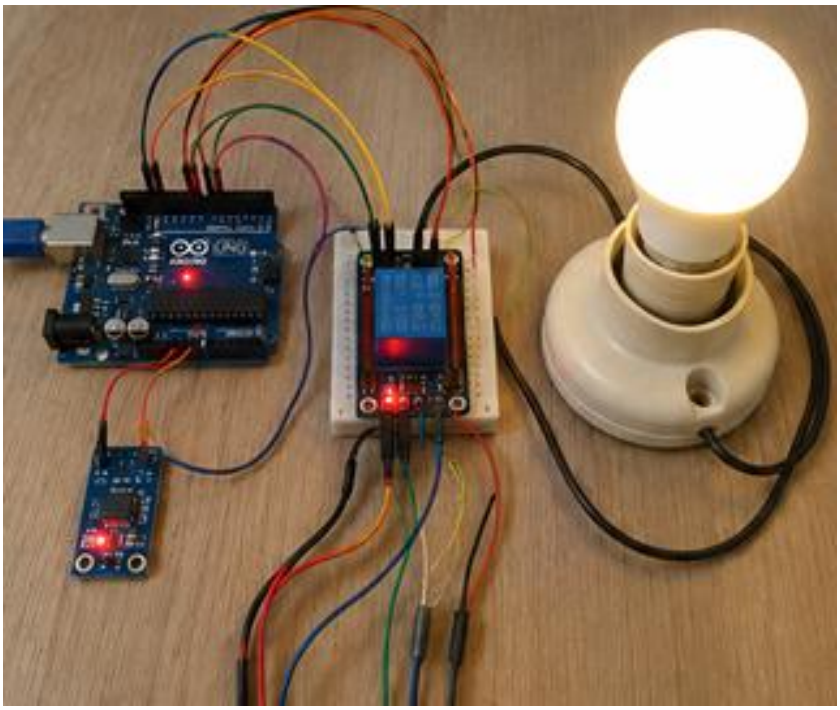
Through this process, students developed practical skills that are difficult to obtain through theoretical instruction alone.

3. System Testing

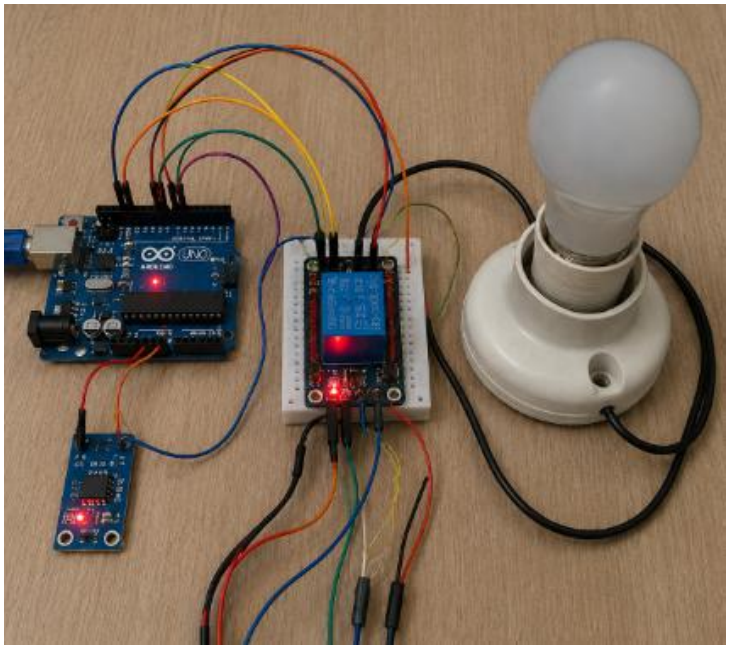
System testing was conducted under different environmental lighting conditions. The purpose of the test was to determine whether changes in light intensity produced the expected response from the lighting system.

Table 1. System Testing

Test Condition	BH1750 Reading	Expected Lamp Status
Bright environment	High	Off
Moderate environment	High	Off
Low-light environment	Low	On
Dark environment	low	On



Ficture 1. Expected Lamp Status High



Ficture 1. Expected Lamp Status Low

4. Discussion

The implementation of an Arduino-based automatic garden lighting project provides a practical context for learning microprocessor systems. Students can directly observe how a sensor provides input, how the microcontroller processes the input, and how an actuator responds to the processed information.

This integrated process is important because microprocessor education should not be limited to programming skills. Students need to understand the interaction between electronic hardware and software. The project approach creates an environment in which students can apply theoretical concepts to a functional system.

The project also provides an opportunity to introduce students to basic automation and Internet of Things concepts. Although the system developed in this project does not require Internet connectivity, the architecture can be further developed by adding Wi-Fi connectivity, remote monitoring, data logging, or mobile application control.

From a learning perspective, the project encourages students to become active participants. The lecturer acts as a facilitator who provides guidance and technical direction while students are responsible for completing the project.

This learning model is relevant to competency-based education because the final evaluation considers both the process and the resulting product. Students are not only expected to understand concepts but also to demonstrate that they can apply those concepts to solve a practical problem.

CONCLUSION

The implementation of Project-Based Learning through the development of an Arduino Uno-based automatic garden lighting system provides a practical learning activity for the Microprocessor Systems course. The project enables students to integrate microcontroller

programming, sensor interfacing, electronic circuit assembly, relay control, system testing, and troubleshooting into a single functional application.

The learning activities also support the development of technical and soft skills. Students gain experience in circuit assembly, programming, problem-solving, teamwork, critical thinking, and technical presentation. The automatic garden lighting project therefore provides a relevant context for connecting theoretical microprocessor concepts with real-world automation applications.

Project-Based Learning can consequently be used as an alternative instructional strategy in Microprocessor Systems courses, particularly when the learning objective is to develop students' practical competencies. Future projects can be expanded by integrating Internet of Things technology, wireless communication, cloud-based monitoring, or mobile applications to provide more advanced learning experiences.

REFERENCES

Arikunto, S. (2019). Prosedur Penelitian: Suatu Pendekatan Praktik. Jakarta: Rineka Cipta.

Fatimah, A., Magdalena, M., Suryadi, S., & Kristanti, I. (2024). Implementasi Project Based Learning, Contextual Teaching and Learning untuk Meningkatkan Kompetensi Mahasiswa. Jurnal Ilmiah Edunomika, 8(1). https://doi.org/10.29040/jie.v8i1.11226

Isnaini, M., Hutahaean, H. D., Waluyo, B. D., Solihin, M. D., & Sulaiman, M. (2025). Pengembangan Trainer Sistem Mikroprosesor Berbasis Internet of Things. Jurnal Teknologi Pendidikan, 17(2). https://doi.org/10.24114/jtp.v17i2.65187

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-Based Learning: A Review of the Literature. Improving Schools, 19(3), 267–277. https://doi.org/10.1177/1365480216659733

Lesmana, C., & Jaedun, A. (2015). Efektivitas Model Project Based Learning untuk Meningkatkan Hasil Belajar Mahasiswa STKIP PGRI Pontianak. Jurnal Pendidikan Vokasi, 5(2), 137–148. https://doi.org/10.21831/jpv.v5i2.6382

Najamuddin, F., & Wahrini, R. (2024). Efektifitas Model Pembelajaran Project Based Learning terhadap Hasil Belajar pada Mata Kuliah Sistem Mikroprosessor Program Studi Teknik Elektronika FT UNM. Prosiding Seminar Nasional LP2M Universitas Negeri Makassar, 7.

Susanta, M. H., & Sururi, S. (2026). Project-Based Learning in Microprocessor Systems Courses to Improve the Competencies of Computer Technology Students. ALPEND: Jurnal Pendidikan dan Pembelajaran, 1(1).