

ELECTRONICS FUN HOURS: DEVELOPMENT OF ANALOGUE LINE FOLLOWER MODUL AS AN INTERACTIVE LEARNING APPROACH FOR HIGH SCHOOL STUDENTS

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ABSTRAK

Abstrak: Peningkatan kemampuan praktikal dalam bidang elektronika sangat penting diajarkan pada siswa khususnya pada tingkat menengah atas. Namun, peningkatan skill praktikal biasanya hanya menggunakan modul terstruktur yang diberikan secara berkala. Diperlukan sebuah pengalaman pembelajaran lain untuk meningkatkan skill siswa dalam bidang perangkaian elektronika yang dikombinasikan dengan kemampuan berkolaborasi dan berkompetisi antar kelompok. Agenda yang dilaksanakan oleh tim dosen dan Mahasiswa Telkom University bertujuan untuk mengasah kemampuan perangkat keras siswa menengah atas dalam bidang elektronika yang diikuti dengan peningkatan *softskill* di bidang manajerial kelompok dan kompetisi. Metode yang digunakan adalah berupa pemaparan materi singkat sebagai pengantar, diikuti dengan perangkaian hardware aplikasi line follower secara berkelompok. Hasil dari rangkain robot analog line follower dipertandingkan oleh siswa dalam bentuk kelompok. Kegiatan ini diikuti oleh 30 siswa yang dibagi menjadi 6 kelompok. Berdasarkan hasil wawancara dan evaluasi angket, lebih dari 90% siswa menyatakan acara ini bermanfaat bagi mereka untuk meningkatkan kemampuan dibidang elektronika. Selain itu, lebih dari 92% siswa menyatakan kegiatan ini memberikan pengalaman baru dalam pembelajaran elektronika secara praktikal.

Kata Kunci: Elektronika Analog; Line Follower; Pembelajaran Aktif Siswa; Robot Analog.

Abstract: The improvement of practical skills in the field of electronics is very important to teach students, especially at the upper secondary level. However, the improvement of practical skills usually only uses structured modules provided periodically. Another learning experience is needed to enhance students' skills in the field of electronic circuit design, combined with the ability to collaborate and compete among groups. The agenda carried out by the team of lecturers and students from Telkom University aims to sharpen the upper secondary students' hardware skills in the field of electronics, followed by the enhancement of soft skills in group management and competition. The method used was a brief presentation of the material as an introduction, followed by the assembly of line follower application hardware in groups. The results of the analog line follower robot assembly were competed by the students in groups. This activity was participated in by 30 students divided into 6 groups. Based on the results of interviews and questionnaire evaluations, more than 90% of students stated that this event was beneficial for them in improving their skills in the field of electronics. In addition, more than 92% of students stated that this activity provided new experiences in practical electronics learning.

Keywords: Analog Electronics; Line Follower; Student Active Learning; Analog Robot.



Article History:

Received: 08-01-2025

Revised : 20-02-2025

Accepted: 21-02-2025

Online : 08-04-2025



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A. INTRODUCTION

Knowledge of basic electronics concepts is essential in an electronics-based world, especially concerning human resources among students (Omena et al., 2024). Electronics is one branch of electrical science that studies the application of semiconductor components. Basic electronics knowledge includes electrical circuits, electronic components along with their working principles, and their applications in electronic circuits (Montesdeoca et al., 2022; Yang et al., 2020).

Line follower is a robotics application that consists of various electronic components (Štuikys & Štuikys, 2015). Line follower robots can be made in the form of analog or digital circuits with varying levels of technology. The development of line followers is one of the analog technologies that can be used as a learning medium in the field of analog electronics for general and vocational high school students (Mayub et al., 2023).

However, in the conventional learning concept at senior high schools, electronics is often taught using complex formulas and mathematical calculations that overwhelm students, making it difficult for them to understand the essence and its application in practical settings (Hashim et al., 2023). In SMKN 4 Bandung, many subjects have had practical teaching as the media of teaching and learning activities. However, the practical teaching concept that has been done was limited into laboratory scale practical teaching using systematic modules. The curriculum for practical teaching in collaboration is also limited to focus on individual skill instead of collaboration and competition skills.

In the previous activities, Learning based on student activities have proven its effectiveness to increase critical thinking of students, especially for junior and senior high schools (Gonçalves et al., 2019; Teixeira et al., 2022). (Pérez & López, (2019) had developed an ultra-low-cost line follower robot as an educational media in teaching electronics and programming for students. Another project was developed by Budiya et al. (2020) to increase comprehensive learning process among adolescent to about robotics through an ADDIE method (analysis, design, development and evaluation).

In Japan, the robotic based education has been developed since 2002 by Nakauchi & Simmons (2002) from the basic of design, modelling the social behaviour of robotic development. In the projects of robotic assembling by Mayub et al. (2023); Umar et al. (2014), students points their interactive learning process and improved skills in soldering, deciding right components and mapping the characteristic of each component that supported the robots. These achievements also have affected the social interactions between students as they have to collaborate among them to achieve an effective and well working line follower robots.

Therefore, a team of lecturers and students from Telkom University initiated the development of an educational technology beneficial for vocational and general school students to accommodate not only skills but

also fundamental knowledge in an interactive atmosphere that can enhance students' interest in learning. This social project activity aims to improve the hardware skill of high school students. Not limited on the individual skill, this activity is also focused on the collaboration among students to finish an objective task and compete with other groups in a competition. Therefore, the activities were aimed not only to increase the individual skill but also social skill of the students.

The presentation of electronics material using interactive technology is encapsulated in the "Electronics Fun Hours" agenda, aimed at meeting students' learning needs in terms of fundamental knowledge without involving complex mathematical formulations, supported by hands-on practice to create an electronic circuit. The development of this learning technology also involves active participation from students by holding competitions for assembled electronic circuits, ensuring that all aspects of learning are met through this series of activities.

B. IMPLEMENTATION METHOD

SMKN 4 Bandung is one of the vocational high schools focused on the field of electronics. As a community service partner, SMKN 4 has various vocational concentrations ranging from power systems, industrial control, informatics, and electronics. SMKN 4 Bandung is located in Buah Batu and has become a community service partner of Telkom University. The students of SMKN 4 Bandung have previously participated in training on electromagnetic applications, and it is hoped that the partnership with SMKN 4 Bandung will continue in the future to enhance students' learning motivation and provide a different learning experience.

Targeted schools for electronics fun hours have great potential to become agents of change in increasing students' interest and understanding of electronics concepts through innovative learning concepts (Lo, Hsieh, Lin, & Hung, 2021). Some empowerment potentials for the target schools for the electronics fun hours event are the Improvement in Education Quality, Development of Science and Technology Interest, strengthening Teacher Skills, Community Involvement.

The activities in this social project was conducted through teaching, assembling, and competition among students. At the end of the program, students shared their thoughts about this program and filling survey that was given to them. This social program is divided into three phases; Planning, actuating and evaluation. At the planning stage, an initial visit was conducted by the team to SMKN 4 Bandung. Based on the initial visit, the team received some suggestions regarding the social project concept and its implementation through several suggested solutions such as:

1. Selection of Event Concepts and Technology Topics

The design and concept of technology and electronic applications to be taught have been thoroughly planned by the faculty team, including the level of difficulty and competencies to be achieved. At this design stage, an analog line follower was chosen as the learning technology medium to align with the basic electronics competencies that will be taught before the assembly begins.

2. Attractive Activity Design

This activity is meticulously designed to enhance interaction between students, lecturers, and students who serve as trainers in the development of this line follower technology. Interaction among all parties will increase students' curiosity to explore technology further and not easily give up in developing the assembly of this line follower application. Here, the students will be actively involved in guiding the pupils to complete their assembly.

3. Active Participation in Planning

The activity concept designed by the lecturers from Telkom University has been discussed and socialized with the school and students. This is to prevent misinformation during the implementation of the activities. Approval from the principal or the school representative serves as evidence that the overall event concept has been socialized.

4. Attractive Promotion and Publicity

To enliven the event, promotion has been carried out through both print and digital media. In print, this activity will use posters and attractive announcements. Digitally, the results of this activity will be published on the website of the Energy System Engineering study program so that prospective students who are currently pursuing high school education can obtain information about the activities that have been carried out by the study program. This can also foster students' interest in continuing their studies at Telkom University.

5. Evaluation and Continuous Learning

After the event is over, conduct a thorough evaluation to assess the success of the event and gather feedback from the participants. Use the evaluation results to improve and enhance future events, as well as to serve as a basis for continuous learning for both organizers and participants. By systematically implementing these solutions, the team can address various issues that may arise in the organization of Electronics Fun Hours and ensure that the event becomes a beneficial and enjoyable learning experience for all.

For the second stage is the implementation of electronics fun hours. The activities started by presenting introductory of line follower following with how to assemble a line follower robot. After the presentation, the students were divided into 6 groups with 5 persons to assemble the analog robot with guidance from the university students. The process took almost an hour to

finish the assembling. After the assembling done, the student charged their robot battery before the match. The match was done twice to seek for the champion who can follow the line at a little time. The last stage is the evaluation that was done after the competition done. The evaluation was done through an open discussion by the students to give their though regarding this program. Moreover, a systematic survey was given to the students to evaluate the whole program and the improvement their achieve after this program.

C. RESULTS AND DISCUSSION

Following the suggested solutions in the methods, the social project implementation had been done through a one-day program. The community service activity was opened by the principal of SMKN 4 Bandung and also by the representative of Telkom University lecturers. At the opening, the committee provided information regarding the purpose of the community service and the series of events that would be conducted to the 30 invited students. After the opening, students received a brief material from one of the lecturers related to the basics of electronics and the assembly of line follower equipment. An initial introduction to what a line follower is and its applications in the industrial world and transportation of goods.

After that, given a briefing on the basic components of the line follower and the line follower application that will be assembled by students. This includes basic circuit schematics and introduction to its components. Students can follow well because some students already have basic skills in assembling electronic components. Several techniques in assembling components and soldering techniques are also given to provide knowledge about neatness in assembling and ensuring the quality of the circuit, as shown in Figure 1.



Figure1. Progress of Line Follower Circuit Assembling

After the assembly process was complete, the results of the line follower from each group were competed. Students were given time to charge the

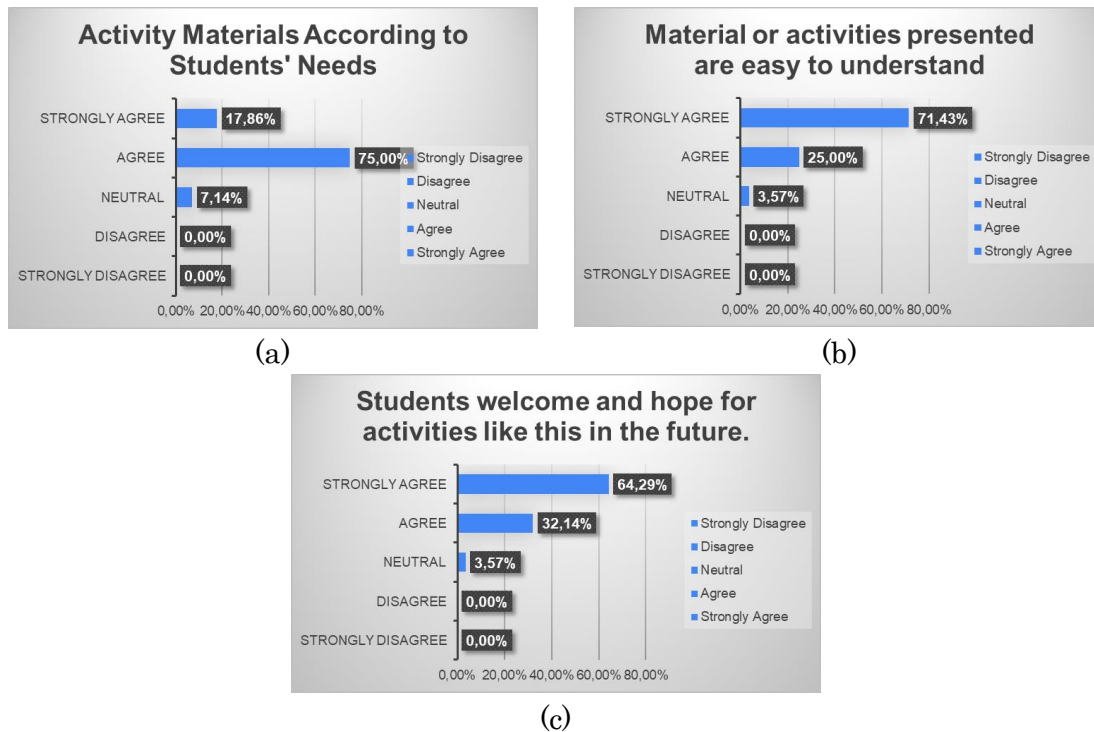
battery installed on the line follower. Meanwhile, students make quizzes for students related to the previous material series. When the charging is complete, the competition begins. Students must pass through the track that has been made by the committee. However, before that they can train and do troubleshooting on a simpler circuit. After there are no problems, students can compete on a longer track, as shown in Figure 2.



Figure 2. Line follower competition series

After several matches between 6 groups of students, the best champions 1 and 2 were awarded prizes. Prizes were presented by representatives of lecturers and students. At this time, a group photo was also taken with the students. Furthermore, the committee took survey for the students regarding the event and the continuity after the event. Furthermore, a group photo was taken with all participants, the lecturer team and students. The event ended at around 2.30 pm and the students were enthusiastic about following the series of events. In addition, a line follower was handed over to the school representative.

Based on the results of the student satisfaction survey on the event assessed from the level of need for training, event implementation time, material presented, committee service and event follow-up, the highest level of satisfaction was 100% for committee service and 96% for future event follow-up. The results of the survey on the provision of activity materials, the process and needs for activity follow-up are depicted in Figures 3.



Figures 3. Survey results regarding the community service program

The first survey conducted regarding the materials given in the program through a sequential activity. Based on Figure 3 (a) Students felt that the materials have been in line with the students need i.e. improvisation of their skill in terms of electronics circuit, collaboration and competition for improving their hard skill and soft skill. More than 17% strongly agree that the improvisation was achieved by this program and 75% agree. Regarding the process of delivery the materials, according to Figure 3 (b), more than 71% students felt enthusiast and receive the information easily as the learning process given in an interactive way and 25% agree the materials are easy to receive. Also, for the future improvements, according to Figure 3 (c) 64% and 32% Student are strongly agree and agree that the kind of program is beneficial for improving their skills, hence it is recommended to have such program in the future.

Several notes on improvements in terms of time management were submitted in a survey by the participants of the activity. Because the event was quite dense including training and competitions, the activity took up quite a lot of time from the planned schedule. However, enthusiasm was still felt by the training participants, especially during the competition. In the future, it is necessary to facilitate heavy consumption if the event lasts longer than scheduled.

D. CONCLUSIONS AND SUGGESTIONS

The survey after the event indicated enthusiasm among the students to take the event as the challenge to improve their skills in basic electronics, assembling the circuit and team managerial. More than 90% students found that this event was very helpful and demanding for the next event to be held in their school. For the next project, the team has a plan for exploring and giving knowledge for the students in terms of renewable energy by collaborating the research topics and the community service program to disseminate the research output from the university to the school through assembling program of renewable energy solar fountain program.

ACKNOWLEDGEMENT

Authors feeling grateful to Research and Community Service Unit of PPM for the contribution to support this service community program through a grant number 0503/ABD07/PPM-JPM/2024.

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