

Profile of Students' Responses to Problem-Based Learning Assisted by EveryCircuit in Electronics Engineering Learning

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ABSTRACT

Electronics Engineering learning requires students' active involvement in understanding problems and analyzing circuits in a contextual manner. Problem-Based Learning (PBL) assisted by EveryCircuit can support this process through problem-solving activities and interactive circuit simulation. This study aims to analyze the profile of students' responses to the implementation of PBL assisted by EveryCircuit in Electronics Engineering learning. The study employed a descriptive quantitative approach involving 36 students as the subjects. Data were collected through a questionnaire consisting of 10 statements using a 4-point Likert scale covering aspects of PBL and EveryCircuit. Data analysis was conducted using score percentages and student response categories. The results showed that the overall student response obtained a percentage of 77.08%, categorized as good. The response to the PBL aspect reached 78.06%, while the EveryCircuit aspect obtained 76.11%; both were categorized as good. The highest response was found in the group discussion indicator, with a percentage of 81.25%, while the lowest response was found in students' interest in using EveryCircuit to learn other electronic circuits, with a percentage of 73.61%. These findings indicate positive student acceptance of the integration of PBL and EveryCircuit and provide an overview of students' experiences in participating in problem-based learning supported by simulation media.

Informasi Artikel

Kata Kunci:

Problem-Based Learning;
EveryCircuit;
Respons siswa;
Teknik Elektronika;
Simulasi rangkaian.

ABSTRAK

Pembelajaran Teknik Elektronika membutuhkan keterlibatan siswa dalam memahami permasalahan dan menganalisis rangkaian secara kontekstual. Problem-Based Learning (PBL) berbantuan EveryCircuit dapat mendukung proses tersebut melalui aktivitas pemecahan masalah dan simulasi rangkaian secara interaktif. Penelitian ini bertujuan menganalisis profil respons siswa terhadap penerapan PBL berbantuan EveryCircuit pada pembelajaran Teknik Elektronika. Penelitian menggunakan pendekatan kuantitatif deskriptif dengan subjek 36 siswa. Data dikumpulkan melalui kuesioner yang terdiri atas 10 pernyataan dengan skala Likert 1–4 yang mencakup aspek PBL dan EveryCircuit. Analisis data dilakukan menggunakan persentase skor dan kategori respons siswa. Hasil penelitian menunjukkan bahwa respons keseluruhan memperoleh persentase sebesar 77,08% dengan kategori baik. Respons terhadap aspek PBL mencapai 78,06%, sedangkan aspek EveryCircuit sebesar 76,11%, yang keduanya berada pada kategori baik. Respons tertinggi terdapat pada indikator diskusi kelompok sebesar 81,25%, sedangkan respons terendah terdapat pada ketertarikan menggunakan EveryCircuit untuk mempelajari rangkaian elektronika lainnya sebesar 73,61%. Temuan ini menunjukkan penerimaan positif siswa terhadap integrasi PBL dan EveryCircuit serta memberikan gambaran mengenai pengalaman siswa dalam mengikuti pembelajaran berbasis masalah yang didukung media simulasi.

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1. Introduction

Electronics Engineering learning in Vocational High Schools (SMKs) is characterized by the need to integrate conceptual understanding with the ability to apply concepts in solving technical problems. Electronics topics involve understanding the relationships among components, circuit characteristics, and analytical processes for determining solutions to specific problems. These characteristics indicate that learning should not merely focus on content delivery but should provide learning experiences that engage students in thinking, analyzing, and solving problems. In vocational education, the use of technology and simulation can support practice-based learning experiences, particularly when learning activities require repeated exploration of electronic circuits [1][2].

One learning model that is consistent with these characteristics is *Problem-Based Learning* (PBL). This model places problems as the primary context for learning, thereby engaging students in understanding problems, seeking information, discussing possible solutions, and formulating solutions. In engineering education, PBL can be implemented in various forms; however, its implementation needs to consider the characteristics of the problems, student activities, learning environment, and the teacher's role [3]. The implementation of PBL in vocational education, particularly in technology and engineering fields, also demonstrates the relevance of this model to learning oriented toward solving vocational problems [4]. In Electronics Engineering learning, the characteristics of PBL enable students to engage with circuit-related problems that encourage analytical processes and solution seeking.

In addition to the implementation of the learning model, student responses are an important aspect to consider when evaluating learning experiences. Student responses can provide an overview of how students perceive learning activities, their involvement in the learning process, and their perceptions of the experiences gained. [5] reported that students perceived PBL as valuable for developing skills related to engineering practice, including collaboration, communication, self-directed learning, and self-confidence. Consistent with this finding, [6] demonstrated that student perceptions are important for understanding the development of generic competencies through PBL in engineering education. Furthermore, [7] examined students' perceptions of PBL in multidisciplinary groups and highlighted the importance of students' experiences in understanding problem-based learning processes. These findings indicate that analyzing student responses can provide insights into students' acceptance and experiences of PBL implementation, rather than merely evaluating learning outcomes.

The need for exploratory learning experiences in Electronics Engineering can be supported through simulation media. Circuit simulation enables students to visually represent components and circuit relationships and observe changes in circuit conditions without always relying on physical equipment. Research on the acceptance of electronic circuit simulation indicates that perceived ease of use and perceived usefulness are factors associated with users' acceptance of simulation technology [8]. [9] also demonstrated that the use of a *web-based circuit simulator* in digital electronics learning can support independent and creative learning activities. In addition, computer-based simulation in electronic circuit learning has been examined in relation to students' motivation, achievement, and cognitive load

[10]. Thus, simulation can serve as a relevant supporting medium in Electronics Engineering learning that requires circuit visualization and exploration.

One simulation medium that can be used for electronic circuit learning is EveryCircuit. The use of EveryCircuit in electronics education has been examined in several studies. [11] developed EveryCircuit-assisted learning materials for the Application of Electronic Circuits subject in vocational high schools, while [12] developed an EveryCircuit-based learning module for the Fundamentals of Electricity and Electronics subject. EveryCircuit has also been used as a virtual practicum medium in basic electronics learning [13]. More recent studies have examined the use of the EveryCircuit application in learning and the development of EveryCircuit-assisted modules [14][15]. These studies demonstrate that EveryCircuit has been utilized as a medium for electronic circuit learning, although the research focuses vary, particularly on instructional material development, media utilization, virtual practicums, and learning outcomes.

Integrating PBL with simulation media provides a different learning context because simulation can serve as a supporting tool when students investigate the problems presented to them. In problem-based learning, students can use simulations to explore possible solutions, observe circuit behavior, and compare calculated results with conditions obtained through simulation. The development of virtual PBL-based learning in vocational education has demonstrated the potential for integrating virtual learning environments with problem-based activities [16]. In electronics education, simulation media have also been developed to support learning about electronic components and circuit-related skills [17][18]. However, research specifically describing students' responses to the integration of PBL and EveryCircuit in Electronics Engineering learning at vocational high schools remains limited and requires further investigation.

Based on previous studies, research on PBL has extensively examined students' perceptions and experiences in engineering education [5][6][19], while research on electronics simulation has addressed technology acceptance, media utilization, virtual learning, and learning outcomes [8][20][14]. This condition indicates a research opportunity to integrate these two perspectives by mapping students' responses to PBL assisted by EveryCircuit. This study is not intended to examine causal relationships or demonstrate improvements in learning outcomes but rather to obtain empirical evidence regarding students' responses to PBL aspects and the use of EveryCircuit in Electronics Engineering learning.

Therefore, this study aims to analyze the profile of students' responses to the implementation of *Problem-Based Learning* assisted by EveryCircuit simulation media in Electronics Engineering learning. The response profile is analyzed based on two main aspects: students' responses to the implementation of PBL and students' responses to the use of EveryCircuit. The findings are expected to provide information regarding the learning aspects that receive the highest responses and those that still require attention, thereby serving as a consideration for teachers in designing and evaluating problem-based Electronics Engineering learning supported by simulation media.

2. Research methods

This study employed a descriptive quantitative approach to describe students' responses to the implementation of Problem-Based Learning (PBL) assisted by EveryCircuit simulation

media in Electronics Engineering learning. This approach was selected because the study did not aim to examine causal relationships or the effectiveness of a treatment, but rather to describe students' perceptions after participating in the learning process.

The research subjects consisted of 36 students participating in Electronics Engineering learning at SMK Negeri 1 Semarang. The subjects were students who participated in learning activities using the PBL model assisted by EveryCircuit simulation media. Data were collected after the entire learning process had been completed through the administration of a student response questionnaire.

The research instrument was a questionnaire consisting of 10 statements using a four-point Likert scale. A score of 4 was assigned to the response "strongly agree," a score of 3 to "agree," a score of 2 to "disagree," and a score of 1 to "strongly disagree." The questionnaire covered two aspects: PBL and EveryCircuit. The PBL aspect included students' interest in problem-based learning, understanding of the learning material through problems, active participation in discussions, ability to find solutions, and confidence in presenting the results. The EveryCircuit aspect included ease of understanding circuits, observation of current and voltage, verification of calculation results through simulation, understanding of series, parallel, and mixed circuits, and students' interest in using EveryCircuit again.

Instrument validity was tested by comparing the values of r_{hitung} and r_{tabel} at a significance level of 5%. The test results from 36 respondents showed that all statement items had values ranging from 0.767 to 0.935. These values were greater than r_{tabel} , which was 0.329; therefore, all 10 statement items were declared valid. Instrument reliability was tested using Cronbach's Alpha coefficient. The test resulted in a Cronbach's Alpha value of 0.967, indicating that the instrument had very high reliability.

The data were analyzed using descriptive statistics, including actual scores, maximum scores, percentages, and the mean student response score. The percentage of student responses was calculated using the following formula:

$$P = \frac{S}{S_{maks}} \times 100\%$$

where P represents the response percentage, S represents the actual score obtained, and S_{maks} represents the maximum score. With 36 respondents and a highest score of 4, the maximum score for each statement item was $36 \times 4 = 144$. Meanwhile, the overall maximum score for the questionnaire was $36 \times 10 \times 4 = 1.440$.

Students' response percentages were interpreted using five categories: 81–100% was classified as very good, 61–80% as good, 41–60% as fair, 21–40% as poor, and 0–20% as very poor. These categories were used as interpretation criteria in this study and were not intended to represent universal standards. The results of the analysis were subsequently used to describe the tendency of students' responses to the implementation of PBL assisted by EveryCircuit.

3. Results and discussion

3.1. Results

Before being used to analyze the profile of students' responses, the questionnaire instrument was tested for validity and reliability. The validity test was conducted on 10 statement items

involving 36 students as respondents. At a significance level of 5%, the obtained r_{tabel} value was 0.329. The results showed that the r_{hitung} values for all items ranged from 0.767 to 0.935. Therefore, all items had values greater than $r_{hitung} > r_{tabel}$ and were declared valid.

The reliability test resulted in a Cronbach's Alpha value of 0.967. This value indicates very high internal consistency; therefore, the instrument was considered highly reliable. Accordingly, all 10 statements were suitable for analyzing the profile of students' responses to PBL-assisted learning using EveryCircuit.

The response analysis involved 36 students using a 4-point Likert scale. The maximum score for each statement was calculated as follows: $36 \times 4 = 144$. The results of the analysis for each statement are presented in Table 1.

Table 1 Profile of Students' Responses to PBL Assisted by EveryCircuit

No	Aspect	Actual Score	Maximum Score	Percentage (%)	Category
1	PBL	115	144	79,86	Good
2	PBL	112	144	77,78	Good
3	PBL	117	144	81,25	Very Good
4	PBL	109	144	75,69	Good
5	PBL	109	144	75,69	Good
6	EveryCircuit	108	144	75,00	Good
7	EveryCircuit	111	144	77,08	Good
8	EveryCircuit	112	144	77,78	Good
9	EveryCircuit	111	144	77,08	Good
10	EveryCircuit	106	144	73,61	Good

Based on Table 1, most indicators received responses in the good category. Only indicator P3 reached the very good category, while the other nine indicators were categorized as good. The highest response was obtained for the statement that group discussions helped students understand how to solve circuit-related problems, with a percentage of 81.25%. Meanwhile, the lowest response was found for students' interest in using EveryCircuit to learn other electronic circuits, with a percentage of 73.61%.

To obtain a more general overview, the five PBL statements and the five EveryCircuit statements were analyzed as two separate aspects.

Table 2 Recapitulation of the Response Profile by Aspect

Aspect	Number of Statements	Actual Score	Maximum Score	Percentage (%)	Category
PBL	5	562	720	78,06	Good
EveryCircuit	5	548	720	76,11	Good
Overall	10	1.110	1.440	77,08	Good

The results presented in Table 2 show that students' responses to the PBL aspect reached 78.06%, while their responses to the EveryCircuit aspect reached 76.11%. Both aspects were categorized as good. Overall, the students' response score was 1,110 out of a maximum score of 1,440, corresponding to 77.08%. Therefore, the overall profile of students' responses to PBL-assisted learning using EveryCircuit was categorized as good. The research tabulation data also showed a total score of 1,110, with an overall response percentage of 77.08%.

3.2. Discussion

The results showed that students' responses to the implementation of *Problem-Based Learning* (PBL) assisted by EveryCircuit obtained an overall score of 1,110 out of a maximum score of 1,440, corresponding to 77.08% and falling into the good category. This finding indicates that, in general, students responded positively to the learning experience that combined problem-solving activities with the use of circuit simulation media. This response does not indicate the effectiveness of the learning approach in terms of learning outcomes but rather reflects the level of students' acceptance of the learning process they experienced. The response profile also showed that the PBL aspect obtained a percentage of 78.06%, while the EveryCircuit aspect obtained 76.11%. The difference was relatively small, suggesting that the two components can be viewed as complementary elements of students' learning experiences.

For the PBL aspect, the statement regarding group discussions helping students understand how to solve circuit-related problems received the highest score, at 81.25%, which was categorized as very good. The high response to this aspect indicates that collaborative activities were the most positively received component of PBL implementation. Discussions provided opportunities for students to exchange ideas, compare solution strategies, and develop a shared understanding of circuit-related problems. This finding is consistent with [5], who reported that students' experiences with PBL were associated with the development of professional skills, including collaboration and communication. Furthermore, [6] emphasized students' perceptions of generic competency development as an important component of PBL experiences in engineering education. Thus, the high response to group discussions in this study can be interpreted as an indication that students perceived collaborative activities as a meaningful part of the problem-solving process.

The positive response is also consistent with the characteristics of PBL, which position students as active participants in the learning process. Problems are not directly presented as predetermined procedures that students must follow; instead, they serve as starting points for students to identify relevant information, discuss alternatives, and determine solutions. This is consistent with [3], who explained that the implementation of PBL in engineering education involves various activities that encourage student engagement in problem-solving processes, although its implementation remains influenced by instructional design and learning context. In the context of vocational education, [21] and [4] also demonstrated the relevance of PBL to technology- and vocational-oriented learning. Therefore, the good response to the PBL aspect in this study may be associated with the alignment between problem-solving and discussion activities and the characteristics of Electronics Engineering learning.

For the EveryCircuit aspect, students' responses were also categorized as good, with a percentage of 76.11%. This result indicates that students generally accepted EveryCircuit as a supporting medium for electronic circuit learning. Simulation media provide visual and interactive experiences that allow students to observe circuit behavior without always relying on physical components. In problem-based learning, these characteristics can support students when exploring alternative circuit configurations or examining circuit conditions based on the problems they are solving. This finding is consistent with [8], who highlighted the importance of user acceptance of electronic circuit simulation, particularly in relation to perceived ease of use and usefulness. In addition, [9] demonstrated that circuit simulators can support independent and creative learning activities in digital electronics education.

The use of EveryCircuit in this study is also consistent with previous research in electronics education. [11] and [12] used EveryCircuit as part of the development of learning materials for electronics subjects in vocational high schools. In addition, [22] used EveryCircuit as a virtual practicum medium in electronics learning. These studies demonstrate that EveryCircuit can function as a supporting medium in learning activities that require circuit representation and exploration. [14] and [15] also demonstrated the continued development of EveryCircuit use in learning, although their studies focused more on learning outcomes and module development. In contrast, the present study focuses on the profile of students' responses. Therefore, the information obtained concerns not improvements in learning outcomes but how students perceived their learning experience when EveryCircuit was used in conjunction with PBL.

The acceptance of simulation media can also be understood in relation to the exploratory characteristics of Electronics Engineering learning. Students can observe circuit conditions, make modifications, and compare simulation results with previously performed calculations. [10] showed that computer-assisted electronic circuit learning is associated with aspects of motivation, achievement, and cognitive load. Similarly, [20] examined engineering students' attitudes toward virtual laboratories and indicated that user experience is an important aspect in the implementation of virtual laboratory environments. The findings of the present study further support the importance of considering responses to simulation media as part of the evaluation of learning experiences, particularly in engineering education that integrates conceptual understanding with practical or exploratory activities.

Although the overall response was categorized as good, differences among individual items indicate that not all aspects of the learning experience were received at the same level. Statement P3 concerning group discussions obtained the highest score of 81.25%, whereas P10 concerning students' interest in using EveryCircuit to learn other electronic circuits obtained the lowest score of 73.61%. This difference is noteworthy because it indicates that students' strongest response was related to learning interaction, whereas their lowest response concerned their intention to extend the use of the media beyond the learning experience provided. Although the P10 score remained within the good category, indicating a generally positive response to EveryCircuit, students' interest in using the media for other topics was not as strong as their response to the PBL discussion activities.

These findings imply that students' response profiles do not merely indicate whether a learning approach is accepted but also

reveal which components of the learning process are most prominent from the students' perspective. In this study, discussion and collaboration emerged as the strongest aspects, while students' intention to use EveryCircuit again received a relatively lower score. This finding may be considered by teachers when maintaining collaborative activities within PBL while simultaneously improving students' experiences with simulation media by providing broader opportunities to explore electronic circuits. The study by [16] on virtual PBL-based learning in vocational education supports the importance of integrating virtual learning environments with problem-based activities. Similarly, [2] demonstrated the relevance of *simulation-based learning* in basic electronics education in relation to practical learning experiences.

Overall, the response profile of 77.08% indicates that the integration of PBL and EveryCircuit received good acceptance from students. This finding reinforces previous research reporting positive student perceptions of PBL in engineering education [5], [6] while also supporting studies concerning the use of simulation in electronics learning [8][9]. The contribution of this study lies in mapping students' responses to two learning components simultaneously: PBL activities and the use of EveryCircuit in the context of Electronics Engineering learning at a vocational high school. Therefore, the findings can serve as evaluative information for teachers to understand students' experiences with problem-based learning supported by simulation media, without drawing causal conclusions regarding its effectiveness in improving learning outcomes.

4. Conclusion

This study shows that students' responses to the implementation of *Problem-Based Learning* assisted by EveryCircuit simulation media in Electronics Engineering learning were categorized as good, with an overall percentage of 77.08%. The PBL aspect received a response of 78.06%, while the EveryCircuit aspect obtained 76.11%. The highest response was found for the group discussion aspect, with a percentage of 81.25%, whereas the lowest response was found for students' interest in using EveryCircuit to learn other electronic circuits, at 73.61%. These findings indicate that students showed positive acceptance of the integration of problem-solving activities and simulation in Electronics Engineering learning. The results can serve as a consideration for teachers in evaluating and developing problem-based learning supported by simulation media in accordance with students' learning experiences.

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