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THE INFLUENCE OF THE PROJECT BASED LEARNING MODEL ASSISTED WITH THE ELECTRONIC WORKBENCH APPLICATION ON THE CRITICAL THINKING ABILITY OF ELECTRICAL EDUCATION STUDENTS

Abstrak

Melalui pendidikan tinggi, mahasiswa diberikan pengetahuan dan keterampilan yang diperlukan untuk menghadapi tantangan kehidupan di masa depan. Namun dalam pelaksanaannya, beberapa program studi di kampus mungkin mengalami kendala dalam menyediakan fasilitas dan perlengkapan yang memadai untuk menunjang pembelajaran pada bidang vokasi tertentu. Oleh karena itu, penelitian ini bertujuan untuk mengetahui pengaruh model project based learning berbantuan aplikasi electronic workbench terhadap kemampuan berpikir kritis mahasiswa pendidikan teknik elektro. Metode penelitian yang dilaksanakan berbentuk quasi eksperimen dengan desain penelitian berupa posttest only group design. Populasi penelitian adalah mahasiswa program studi pendidikan teknik elektro, dimana sampel penelitiannya adalah mahasiswa semester gasal yang mengambil mata kuliah rangkaian listrik. Teknik pengumpulan data meliputi tes dan dokumentasi. Teknik analisis data menggunakan uji t. Hasil yang diperoleh adalah uji thitung sebesar 2,630 > ttabel sebesar 2,048. Dengan demikian, dapat disimpulkan bahwa terdapat pengaruh yang signifikan penggunaan model project based learning berbantuan aplikasi electronic workbench terhadap kemampuan berpikir kritis mahasiswa teknik elektro yang mengambil mata kuliah rangkaian listrik.

Kata Kunci: Model Project Based Learning, Proteus, Kemampuan Berpikir Kritis.

Abstract

Through higher education, students are given the knowledge and skills needed to face life's challenges in the future. However, in implementation, some study programs on campus may face obstacles in providing adequate facilities and equipment to support learning in certain vocational fields. Therefore, this research aims to determine the effect of the project based learning model assisted by the electronic workbench application on the critical thinking abilities of electrical engineering education students. The research method implemented is in the form of a quasi-experiment with a research design in the form of a posttest only group design. The research population is students of the electrical engineering education study program, where the research sample is odd semester students who take electrical circuits courses. Data collection techniques include tests and documentation. The data analysis technique uses the t test. The results obtained were that the tcount test was 2,630 > ttable was 2,048. Thus, it can be concluded that there is a significant influence of the use of the project based learning model assisted by the electronic workbench application on the critical thinking abilities of electrical engineering students taking electrical circuits courses.

Keywords: Project Based Learning Model, Proteus, Critical Thinking Ability.

INDRODUCTION

Universities are higher education institutions that aim to provide education and teaching to students at a higher level after completing high school level education. The main goal of higher education is to provide a more in-depth education, increase academic knowledge and skills, and prepare individuals to enter the competitive world of work. Universities also play a role in producing research and developing new knowledge through research activities. Universities can have a variety of study programs covering various disciplines. Starting from the fields of social sciences, economics, to

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natural sciences and engineering. Each of these study programs has relevant courses and faculty who are skilled and experienced in their respective fields.

Universities provide various and in-depth study programs, both in the fields of social sciences, natural sciences, technology, arts, and so on. However, in higher education there are also several problems faced by students. One common problem is the level of difficulty in learning material. Study programs in higher education often have a curriculum that is quite complex and requires in-depth understanding. Students must have good learning abilities and a strong will to face difficult material (Suardi, 2018). Apart from that, the problem of adaptation is also a problem that is often faced by students in higher education. Universities often have a different environment from high schools, so students need to adapt to new environments and academic demands (Mustofa & Mollah, 2019). In facing these problems, it is important for universities to provide adequate support and facilities for students. Apart from that, it is also important for students to have strong motivation and will to face the challenges that exist in higher education.

The level of difficulty in this learning material can come from various factors, such as classes that are too crowded. Then many universities have quite a large number of students in one class. This makes teachers unable to give enough attention to each student. When students have difficulty understanding the material, they will find it difficult to get help from teachers due to limited time and resources (Tanuwijaya & Tambunan, 2021). Furthermore, complex material often has a structured curriculum with complex material (Nurdin, 2018). Students are often faced with material that is difficult to understand or requires in-depth understanding. Sometimes, students feel overwhelmed by the level of difficulty of the material and they have difficulty following it

A further problem, in the aspect of less effective teaching methods, is that the teaching methods used in higher education can also be a factor that causes the level of difficulty in learning material. If the teacher only uses the lecture method without giving students the opportunity to discuss or actively participate in learning, students may find it difficult to understand the material well. Then there is a lack of academic support, in this case some students may experience difficulty learning outside the classroom. It could be that they need additional assistance such as tutoring or adequate library facilities to access reading materials. This lack of academic support can worsen the level of difficulty in learning material. To overcome the level of difficulty in learning material in higher education, there needs to be adequate attention and support for students. Universities can provide tutoring or mentorship programs provided by teachers or senior students to help students understand the material. Creative and interactive teaching methods can also be applied to facilitate students' understanding. Apart from that, it is also important to improve facilities and accessibility of reading materials so that students can access information more easily. With adequate attention and support, it is hoped that students can overcome the level of difficulty in the learning material better.

Vocational or vocational education aims to provide skills and knowledge that are directly related to the world of work (Winangun, 2017). Graduates from tertiary institutions, in this case the study program, are able to absorb human resources to enter the world of work directly after graduating. They have been trained to have specific skills needed by the industry, so it is easier for them to get jobs (Murniati & Usman, 2009). Vocational education can be an alternative for students who do not continue to college. This background emphasizes the importance of preparing the younger generation with practical skills that support the economy and fulfill employment opportunities or adequate human resources in the corporate or industrial sector.

Furthermore, to fulfill industrial needs, of course the world of work has a high demand for workers who have special skills, such as expertise in the fields of engineering, automotive, multimedia, tourism, and so on (Murniati & Usman, 2009). Vocational education certainly supports meeting these needs by preparing students to work in these sectors. Thus, vocational education can also be a solution to facing the problem of unemployment.

In fact, so far there has been a stigma regarding the choice of study program towards higher education which is considered a pathway for students who are unable or less intelligent academically. This is because not all students are confident in their choice of the study program they choose according to their interests or academic abilities that are different from other students. Apart from that, interests and talents have not been properly explored, where many students in tertiary institutions choose study programs without sufficient understanding of their interests and talents. This can make them less motivated and difficult to develop in their chosen field.

Furthermore, some students, especially in the study program they have chosen, face difficulties in exploring the basic knowledge of courses based on the curriculum. This can hinder their ability to understand theoretical lessons and carry out practical tasks involving numbers. Similarly, a small number of campuses have obstacles in providing adequate facilities and equipment to support learning. This limitation can affect the learning experience of students and reduce the quality of education in the study program they can receive by adjusting the curriculum structure of the study program. Actually, the study program provides opportunities for students to develop their potential in their fields of interest.

On the other hand, in the means of supporting the learning process, the curriculum is not in accordance with the needs of the industrial world. One of the problems that often occurs in study programs is a curriculum that is less relevant to the needs of the world of work. This makes it difficult for students to apply the knowledge and skills they learn in study programs in the world of work, one of which is during industrial internships. Apart from that, there is a lack of soft skills development where apart from technical skills, students also need to develop soft skills such as communication skills, collaboration and leadership skills. However, students often do not pay enough attention to developing these soft skills. Please note Teaching students to think critically is one of the main goals of education (Kalelioğlu & Gülbahar, 2014 and Kazempour, 2013). To overcome this problem, there is a need to improve the way of providing learning methods or models adapted to the curriculum that can help students' level of understanding in the learning support facilities industry by supporting activities in the learning process, as well as developing learning programs that are more responsive to the needs of the world of work, one of which is implementation. project based learning model assisted by multisim applications.

Project-based learning (PBL) is a form of active, student-centered teaching characterized by student autonomy, constructive inquiry, goal setting, collaboration, communication and reflection in real-world practice. This has been explored in a variety of different educational contexts and phases, from primary education to higher education (Kokotsaki et al., 2016). Likewise, the project based learning model provides conditions for improving critical and analytical thinking skills and solving complex problems in real life so that it will give rise to a "culture of thinking" in students. This kind of learning process requires students to play an active role in learning activities that are not only focused on to teachers in this way can improve student learning outcomes in the lesson material presented (Robiyanto, 2021).

A learning approach that encourages students to be actively involved in the learning process through projects that are relevant to real life (Sappaile et al., 2023). In this model, students are given assignments or projects that require problem solving, research, and creativity. In project-based learning, students have an active role in determining the project topic to be worked on, creating a work plan, and collecting the necessary data and information (Maryati, 2018 and Umar, 2016). They are also required to collaborate with classmates in working on the project.

Through project-based learning, students can develop various skills, such as the ability to organize and manage time, critical thinking skills, and the ability to communicate and collaborate with other people. Apart from that, students can also expand their knowledge about various topics relevant to the project they are working on. Project-based learning can also motivate students to learn because they feel they have greater involvement in the learning process. By actively involving students in planning, managing, and evaluating their own projects, they will feel they have full responsibility for their learning outcomes (Rambung et al., 2023 & Rati et al., 2017 & Zubaidah, 2016). In this way, learning will be more meaningful if students are active and dedicated in participating in every learning implementation.

However, in its implementation, project-based learning also requires good planning and management to run successfully. Teachers need to provide clear guidance and direction to students to ensure that the projects they work on run according to the desired learning objectives. Furthermore, the project-based learning model is considered to be one of the very good learning models in developing various basic skills that students must have, such as decision-making skills, creativity and problem-solving abilities (Rati et al., 2017 & Zubaidah, 2016). In this way, the project based learning model is not only centered on the role of the teacher but is also centered on students by investigating, collaborating between students, communicating and reflecting which can solve problems together by thinking critically and creatively as evidenced by the results of students' work or hand projects. Of

course, support for this learning model can be linked to testing equipment that can be simulated in the form of applications, especially in practical subjects, by connecting theoretical material specifically in electrical circuit subjects with the electronic workbench (EWB).

Electronic workbench is an electronics application that is used to study changes in values in the form of current, voltage, waves, etc. related to the symptoms that arise in a closed circuit and analyze them without having to do actual practice (Hutagalung et al., 2020). This application is a forum for studying electronic circuits by simulating how analog and digital electronic circuits work (Putro, 2015). With the support of this application in the learning process, at least it doesn't make students stiff in learning and understanding the learning that is presented in real terms by proving theory by connecting it to practice. This support is what the teacher's role is to do in the learning process by involving the steps of the project based learning model assisted by the Electronic Workbench application. As a result of this achievement, the teacher certainly hopes that students' thinking abilities will improve.

Critical thinking ability is one of the important skills that every student must have in the learning process. Critical thinking allows students to develop analysis, evaluation and synthesis skills of the information received. In the learning context, students who have critical thinking skills tend to be able to question the information they receive. They don't just accept information at face value, but they try to dig deeper and seek deeper understanding. By thinking critically, students can evaluate the truth of claims and information provided, as well as identify strong and weak arguments.

Furthermore, critical thinking also allows students to develop good argumentation skills. They can build logical arguments and are based on accurate information. This ability is very important in dealing with complex problems, where students need to construct neat and consistent arguments. Apart from that, critical thinking also helps students recognize the assumptions underlying information or arguments. They can critically analyze these assumptions, as well as identify discrepancies between assumptions and existing facts or information (Putri et al., 2019). This is important in avoiding the spread of information that is inaccurate or based on false assumptions. In order to develop students' critical thinking abilities, teachers have an important role in supporting and facilitating students in practicing this ability. Teachers can provide various tasks or exercises that encourage students to think critically, such as analysis or problem solving tasks (Siswono & Novitasari, 2007). Thus, teachers also need to provide constructive feedback and facilitate discussions that encourage students to think more deeply.

It is important for students to have good critical thinking skills, students will be better prepared to face complex challenges in life outside of school. They will be individuals who are able to critically analyze the information they receive, defend strong arguments, and produce more innovative and creative thinking. Critical thinking ability as self-regulation in deciding (judging) something that results in interpretation, analysis, evaluation, and inference, as well as presentation using evidence, concepts, methodology, criteria, or contextual considerations on which decisions are made (Facione & Facione, 2013) .

An intellectual who thinks critically is able to generate ideas, paths in academic thinking and have implications in everyday life. This is what makes critical thinking skills very necessary for every student to be able to face problems, especially problems in life (Elder & Paul, 2019). Likewise, critical thinking ability is a measure of the quality of human ability to know and reason about criticality in the surrounding environment, which is actively involved based on knowledge and responsiveness (Williams & Williams, 2011). Thus, it is very necessary to have an image of an educator, especially in managing learning activities in the classroom by linking basic material to subjects that are adapted to targeted learning models in order to develop students' potential in terms of critical thinking.

METHODS

This research was carried out to obtain data results and objectives that the researcher wanted to achieve when making observations. The research method that researchers carry out is in the form of a quasi-experiment or known as quasi-experimental. Next, the research design was carried out using a posttest control group design which is seen in Table 1 below.

Table 1. Research Design

Class	Treatment	Posstest

Experiment	X	Q1
Control	-	Q2

Information:
X: Treatment using the pjbl model assisted by the EWB application
Q1 and Q2: Giving critical thinking ability tests

On this occasion, the research only used research subjects from odd semester students who took the Electrical Circuits course, totaling 28 students. The experimental group consisted of 14 students while the control group consisted of 14 students. The experimental group was given treatment using the pjbl model assisted by the EWB application. Data collection techniques include tests and documentation. Then the data analysis technique is a normality test using the Shapiro Wilk where the sample is less than 50 respondents and a homogeneity test using the homogeneity test and hypothesis testing is carried out using the T test in the SPSS 16 program.

RESULT AND DISCUSSION

The research was carried out in the odd semester of the 2022/2023 academic year with the electrical circuits course in the electrical engineering education study program. The research was conducted for 6 weeks. During the process of carrying out research activities, researchers have determined classes based on purposive sampling techniques where classes have been determined based on school provisions. So for class XB the researchers made it the experimental class, and class A the control class. Next, the research provided treatment for 4 weeks and finally a test was given to the two classes to find out to what extent they could understand and deepen the material that had been absorbed. The following are the results of data acquisition to find out how much students scored for critical thinking skills when given the test, which can be seen in the descriptive table in Table 2 below.

Table 2. Description of students' critical thinking ability scores

Class	**Sum Student**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Control	15	60	90	79.00	8.70
Experiment	15	75	95	86.33	6.39

source of data in spss

Based on the results obtained in table 2 above, it can be explained that after being given the final test, the students' average scores were different between the two. This can be explained by the fact that the average value obtained by students for the experimental class is 86.33, where the minimum value obtained is 75 and the maximum value obtained is 95 and the standard deviation is 6.39. Likewise, the average score for the control class is 79.00, where the minimum score for students is 60 and the maximum score is 90 and the standard deviation is 8.70. So, analytically, the data obtained in both classes shows that the results of critical thinking skills after carrying out the learning process between the two classes experienced quite significant differences.

Next, to find out whether the data obtained for the two classes is normally distributed, some kind of calculation is needed using SPSS version 16 with Shapiro Wilk. This is done of course according to research guidelines, if the research sample is > 50 respondents, then use the Kolmogrov Smirnov normality test, but if < 50 respondents use Shapiro Wilk. The distribution of the two classes is said to be normal after testing to determine how normal it is using the Normality test. The following is the normality test data obtained for the experimental class and control class in table 3 below

Table 3. Normality test of students' critical thinking abilities

Test variables	**Class**	**Normality test of Shapiro wilks**		
		Statistic	**Sum student**	**Sig**
Critical thinking abilities	Control	0.920	15	1.89
	Experiment	0.90	15	0.94

source of data in spss

The results obtained in table 3 above show that the significance of the data results for critical thinking abilities in the normality test in both classes, namely the experimental, was 0.94 while the control was 1.89. in the normality test, if the sig value is > 0.05, it is said that the results achieved are normally distributed. Based on the results of critical thinking skills, both classes have a significant value of 0.05. This means that students' critical thinking abilities for the control and experimental classes are both normally distributed. Next, it is necessary to prove it again by carrying out a homogeneity test to see how much the students' critical thinking abilities are similar to the Levenes test in the independent sample test in table 4 below.

Table 4. Homogeneity test of students' critical thinking abilities

Test variables	**Assumption**	**Uji Homogenitas Levene's test of variances**	
		F	**Sig**
Critical thinking abilities	Equal Variances Assumed	1.049	0.315
	Equal Variances not Assumed		

source of data in spss

The results obtained in Table 5 above show that the data results for the homogeneity test for students' critical thinking abilities obtained from the Levenes test were significant at 0.315 > 0.05. as in making decisions in this test that they have the same or homogeneous variants. Then after processing the data for both normality and homogeneity tests as a follow-up condition that both have a normal distribution and both variants are homogeneous or the same, then proceed to the testing stage. The following are the achievements of critical thinking skills carried out in the tests in table 5 below.

Table 5. Test the research hypothesis using the test

Test variables	**T-test**		
Critical thinking abilities	**tcount**	**Sum students**	**Sig (2-tailed)**
	2.630	28	0.014

source of data in spss

In table 5 above, the test results show that the sig value is 0.014 < 0.05 or tcount is 2,630 > ttable is 2.048, so as with decision making in the independent sample t test, it can be concluded that Ho is rejected and Ha is accepted. Thus, it can be concluded that there is a significant difference in influence between the average critical thinking ability of students on students who use the project based learning model assisted by the EWB application and students who use the conventional model assisted by EWB.

Furthermore, after completing the research, the researcher obtained good observations that changed learning patterns to be more focused and able for students to be actively and critically involved in carrying out learning. This can be seen when the learning process uses a project based learning model assisted by an electronic workbench. Students begin to observe and pay attention to students planning their projects, identifying topics or research questions, determining action steps, and arranging project implementation schedules. In line with Pratiwi & Setyaningtyas (2020), the project-based learning model is better able to demonstrate students' critical thinking abilities. This was also conveyed by the teacher when the observation was carried out, the teacher said that the students were very enthusiastic and able to develop a sense of curiosity and thoroughness which is one of the characteristics of critical thinking when implementing a project-based learning model.

Then during the learning process the teacher conveys the learning material and how students work in their project groups. Instructions are clear and facilitate discussion, and students actively participate and collaborate within their groups. Then the students use resources and materials to research their project topic, then the students carry out trials or experiments in their projects. Furthermore, they actively think critically and are involved in the learning process, asking questions, looking for answers, and participating in discussions. Through this direct observation, observers can

identify the strengths of the project-based learning model so that they can provide useful feedback for teachers and students to improve the quality of learning in the future. In the Project Based Learning Model, the learning process provides new challenges to students, students' critical thinking skills develop well, students' ability to observe and assess the credibility of sources develops well, basic level clarification develops well, students focus on the statements or problems given, analyze argue well and be able to ask and answer questions given. Students are able to conclude material and data in the process of deduction and induction well (Diarini et al., 2020). Thus, of course, the learning process determines whether students' actions and interactions with their peers and their environment will run well.

Furthermore, the use of STEM-based project-based learning models is more effective in improving students' critical thinking skills. There are several things in the learning model used that also influence students' critical thinking skills in the classroom. Individual skills or the abilities of each student are an important factor in the influence of improving critical thinking skills (Dywan & Airlanda, 2020). Project Based Learning is very suitable to be applied to multidisciplinary sciences and is able to motivate students to complete projects even though at first they find them uninteresting and boring (Virtue & Hinnant-Crawford, 2019). Thus, it is evident from the learning observation process in using the project based learning model that the level of students' understanding has increased in the aspect of critical thinking ability after carrying out targeted, effective and efficient learning steps according to subjects that contain problem solving based on theoretical evidence through practical implementation

CONCLUSION

Based on the results and discussions carried out by researchers, it was concluded that students' critical thinking ability achievements in the electrical circuits course which used the project based learning model assisted by the electronic workbench application had an average competency achievement of 86.33 which was better than learning using the conventional model. with the electronic workbench application of 79. Furthermore, the results of students' critical thinking skills showed that the significance value of tcount was 2,630 > ttable of 2,048, so as with the decision made in the independent sample t test, it could be concluded that Ho was rejected and Ha was accepted. Thus, it can be concluded that there is a significant influence between the average critical thinking ability of students on students who use the project based learning model assisted by the EWB application and students who use the conventional model assisted by EWB. Of course, achieving these results means that students' critical thinking skills are able to be actively involved and develop the potential for critical and creative thinking in solving problems so that the expected achievement is of course skills in the form of students' work. The learning process that uses this model certainly requires the support of not only lecturers, but also the role of students and learning support facilities that can be carried out effectively and efficiently.

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