Comparison of Basic Learning Outcomes of Electricity and Electronics Using Realistic Mathematics Learning Models and Discovery in Electricity Students

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Abstrak

Pada penelitian ini diketahui bahwa selama proses pembelajaran Dasar Listrik dan Elektronika secara umum masih berpusat pada guru, siswa kurang dilibatkan dalam kegiatan pembelajaran di kelas dan juga hasil belajar siswa belum mencapai kriteria ketuntasan minimal. Oleh karena itu, perlu dikembangkan suatu model pembelajaran untuk mendampingi pembelajaran yang melibatkan siswa. Tujuan penelitian ini adalah untuk mengetahui perbandingan hasil belajar dasar listrik dan elektronika dengan menggunakan model pembelajaran Realistic Mathematics and Discovery pada siswa kelas X kelistrikan di SMK Kristen Elfatah Manado. Penelitian ini merupakan penelitian Quasy Experimental Design. Penelitian ini dilaksanakan pada kelas eksperimen X Listrik A dengan menggunakan model pembelajaran Matematika Realistik dan kelas kontrol X Listrik B dengan menggunakan model pembelajaran Discovery. Teknik pengumpulan data menggunakan tes objektif, observasi, wawancara, dan dokumentasi. Teknik analisis data menggunakan uji-t. Berdasarkan uji t diperoleh thitung > ttabel atau 3,786 > 2,028. Dengan demikian dapat dinyatakan Ho ditolak dan Ha diterima. Dengan demikian dapat disimpulkan bahwa siswa yang diberi perlakuan pembelajaran Matematika Realistik mempunyai hasil belajar yang lebih baik dibandingkan siswa yang diberi perlakuan pembelajaran menggunakan model penemuan.

Kata Kunci: Hasil Belajar, Model Pembelajaran Realistic Mathematics, Discovery

Abstract

In this research, it is known that during the Basic Electrical and Electronics learning process in general it is still teacher centered, students are less involved in learning activities in class and also student learning outcomes have not reached the minimum completeness criteria. Therefore, it is necessary to develop a learning model to accompany learning that involves students. The aim of this research is to determine the comparison of basic learning outcomes of electrical and electronics using the Realistic Mathematics and Discovery learning model for class X electricity students at Elfatah Christian Vocational School, Manado. This research is a Quasy Experimental Design. This research was carried out in the experimental class X Electricity A using the Realistic Mathematics learning model and the control class X Electricity B using the discovery model. Data collection techniques use objective tests, observation, interviews, and documentation. Data analysis techniques use the t-test. Based on the t test, it is obtained that tcount > ttable or 3,786 > 2,028. Thus it can be stated that Ho is rejected and Ha is accepted. Thus, it can be concluded that students with Realistic Mathematics learning treatment have better learning outcomes compared to students with learning treatment using the discovery model

Keyword: *Learning Outcomes, Realistic Mathematics Learning Models, Discovery*

INTRODUCTION

Effective learning is learning that provides opportunities for independent learning or carrying out activities on your own. Students learn while doing activities, with activities they can be more active and gain knowledge, understanding and other aspects of behavior. In this way, students are required to experience for themselves, search for the truth, or try to find something and draw conclusions from the process they experience through teaching and learning activities. Teaching and learning activities vary and their use adapts to the learning objectives to be achieved. In learning the Basics of Electricity, the problem solving models commonly used are experimental models, Realistic Mathematics and discovery, CTL, PBL and learning. Where the existence of this learning model can make students more active, students can find out information for themselves in learning. , can help the teaching and learning process, with active learning it can also make children more enthusiastic and remember the learning they find themselves.

In observations conducted by researchers at Elfatah Christian Vocational School, Manado, especially class Various factors can influence student participation levels, ranging from an uninteresting curriculum, monotonous teaching methods, to internal factors such as lack of self-confidence or a tendency to be passive. In many cases, student activity in class is the main key to improving their understanding of the lesson material. However, when students are not active, the teaching and learning process can be hampered. Apart from that, teaching models that are less varied and less interactive can also make students feel bored and unmotivated to participate actively in the learning process.

Furthermore, students who do not achieve 75% learning completion in a subject can be an important indicator in evaluating the effectiveness of learning, especially in basic electricity and electronics subjects. One of the reasons students experience incompleteness is because the use of various learning models such as realistic mathematics models, problem based learning models that are adapted to each basic competency in the basic electricity and electronics syllabus is not yet optimal. One of the main factors is a lack of in-depth understanding of the subject matter. Some students may experience difficulty understanding complex or abstract concepts, which may hinder their ability to achieve stated learning demands (Mulyono & Hapizah, 2018). Thus, of course there needs to be support for a variety of learning models that adapt to the conditions of each student as well as complex support from learning materials that are adapted to the basic competencies in the syllabus, one of which is a case solving learning model such as the Realistic Mathematics Education model.

In this context, the use of learning models allows students to develop a deeper understanding of the subject matter. With this model, students are actively involved in solving problems that are relevant to real life, which encourages them to connect the concepts they learn with real-world situations (Magdalena et al., 2024; Novarita et al., 2023) . This strengthens understanding of concepts and increases students' ability to apply their knowledge in varied contexts (Karisma & Samsiyah, 2023; Lestari & Kurnia, 2023). In addition, the problem-based learning model also facilitates the development of critical thinking and problem solving skills. Students are invited to identify problems, analyze relevant information, generate alternative solutions, and evaluate the effectiveness of their solutions. This process encourages students to think creatively and analytically, and teaches them to face challenges with a proactive attitude.

In addition to the positive influence on student understanding and skills, the problem-based learning model has also been proven to increase student motivation and engagement in learning. When students see the relevance of lesson material to real life and have the opportunity to be actively involved in the learning process, they tend to be more motivated and enthusiastic to learn (Sutrisno et al., 2023). In the classroom context, the application of the problem-based learning model allows teachers to act as learning facilitators, who guide students in exploration and problem solving without providing direct answers. This creates a collaborative learning environment and allows students to learn from each other (Magdalena et al., 2024; Rusliah, 2021). Thus, student learning outcomes in the classroom are positively influenced by the application of the problem-based learning model, because it enriches their learning experience, promotes critical thinking skills, and increases motivation to learn. one of which is a case solving learning model such as the Realistic Mathematics Education model.

The Realistic Mathematics Education learning model is an approach to mathematics learning that emphasizes reality and the environment as the starting point for learning in everyday life (Rahayu, 2010; Tarigan, 2006). The Realistic Mathematics Education learning model is approach allows students to develop a deeper understanding of mathematics by using contexts that are relevant to everyday life. They emphasize the importance of learning mathematics related to real situations to improve students' understanding and skills (Van den Heuvel-Panhuizen, M., & Drijvers, 2020). Realistic Mathematics Education learning model is an approach that combines learning design and research to improve mathematics teaching (Usdiyana et al., 2009). They highlight the importance of developing a mathematics curriculum that focuses on problem solving and real contexts (Gravemeijer & Cobb, 2006). Furthermore, the steps that need to be adapted to the Realistic Mathematics Education model of learning include 1. Use of Real Context, 2. Observation and Representation, 3. Concept Formation, 4. Concept Enrichment, 5. Reflection and Discussion, 6. Application in New Context, and 7. Evaluation and Feedback (Napitupulu, E. E., Hadi, S., & Waluya, 2018; Suryadi, D., & Saragih, 2017; Yudhanegara, M. R., & Fatimah, 2016).

Meanwhile, the discovery learning model is described as a learning approach where students are given the opportunity to actively explore and discover new concepts through direct experience, discovery and reflection (Fahrurrozi et al., 2022; WH et al., 2023). In this learning model, of course, a learning approach is needed where students are invited to be actively involved in the learning process through exploration, experimentation and discovery (Satria Arief 2017). Then in the learning process in class, of course the teacher takes general steps in the Discovery Learning model starting from 1. Stimulation and Introduction, 2. Independent Exploration, 3. Concept Discovery, 4. Direct Experience, 5. Reflection and Discussion, and 6 Application and Enrichment (Abdul Majid, 2017; Fahrurrozi et al., 2022)

Furthermore, constructivist theory, highlights the active role of individuals in building their own knowledge and understanding through interaction with the environment (Ginting, 2018; Sugiyono, 2017). In addition, technology-based learning approaches, provide new opportunities in facilitating learner-centered learning (Hamalik, 2018). Evaluating learning outcomes is crucial in ensuring the effectiveness of the learning process and determining next steps in improving the quality of education (Sholeh, 2023; Suyanto, 2015). Therefore, a deep understanding of learning outcomes and the various factors that influence them is important for educational practitioners. Highlights the importance of understanding the level of complexity of learning outcomes in the context of Bloom's revised taxonomy (Conklin, 2005). To achieve optimal learning outcomes, a supportive learning environment, meaningful interaction and ongoing evaluation are needed (Marzano, 2010).

Then the factors that influence learning outcomes, including learning methods and models, have become the focus of significant research according to experts in Indonesia. According to Arikunto (2010), choosing learning methods that suit student characteristics can increase learning effectiveness and learning outcomes. The cooperative learning approach, emphasizes collaboration between students in achieving learning goals, which can improve understanding of concepts and learning outcomes (Johnson & Johnson, 2009). The project-based learning model, provides opportunities for students to be actively involved in contextual learning that is relevant to real life, which can increase their motivation and learning outcomes (Hamalik, 2014). In addition, a student-centered learning approach, places students as active learning subjects, which can increase understanding and retention of learning material (Huda, 2013). Factors have an important role in forming a learning environment that supports and creates optimal learning outcomes (Sadirman, 2012). Thus, it is very necessary for a learning process that can determine the comparison of basic learning outcomes of electrical and electronics using Realistic Mathematics and discovery learning models for class X electricity students at Elfatah Christian Vocational School, Manado.

METHODS

This type of research is Quasi Experimental, in this research students are divided into two classes, namely the experimental class and the control class. In the experimental class, learning is carried out using the Realistic Mathematics learning model, and in the control class uses the discovery model. This research is expected to show a picture of the actual situation of learning outcomes for the objects under study, namely by looking at the comparison of student learning outcomes by applying the Realistic Mathematics learning model and the discovery model to student learning outcomes using this research design, namely "randomized control group passtest only design"

Tabel 1. The research design is a posttest only group design

Class	Treatment	Posttest
Experiment	X	Q1
Control	-	Q2

(Source of Sugiyono, 2017)

Information :

X: The treatment of the experimental class is the learning model of realistic mathematic learning models in the basic subjects of electricity and electronics

Qı: The final test given to the experimental class at the end of the research was in the form of a posttest

Q_2: The final test given to the control class at the end of the research was in the form of a posttest

Furthermore, the subjects of this research were class In this study, the research variables were the learning outcomes of experimental class and control class students on the subject of understanding the basics of electronics. The variables measured are student learning outcomes through tests on learning the basics of electronics. Then the data analysis techniques used in this research are the normality test using chi square in SPSS 16, the homogeneity test using the F test and the t test. Next, the procedure for this research can be seen in the diagram 1 below

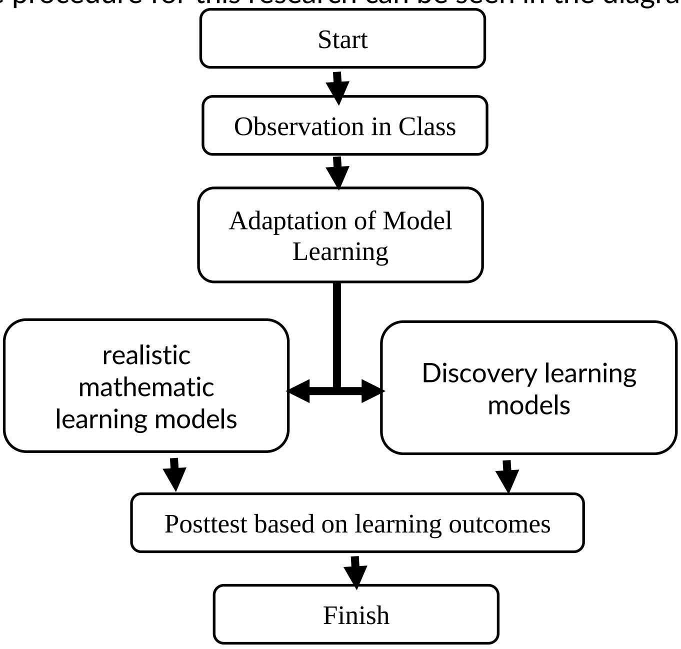

Diagram 1. Research Procedure

RESULT AND DISCUSSION

This research data is in the form of learning outcomes data for experimental class students and control class students. Learning outcome data is in the form of grades for each experimental class student, totaling 20 people and control class students, totaling 18 people. The experimental class students' scores ranged from 70 to 98 and the control class ranged from 60 to 92.

Table 2. Summary of highest value, lowest value, average value, standard deviation and variance

Class	MaximumValu e	Minimum Value	Mean	N	S	s^2
Experime	98	60	80,8	2	7,08	50,2
Control	92	60	78,6	1	6,20	44,6

(source of research data)

Next is a range of learning outcomes for experimental class students. The highest frequency achieved in the control class was the 84-91 interval class with 6 students. To illustrate the results more clearly, you can see the figure 2 below.

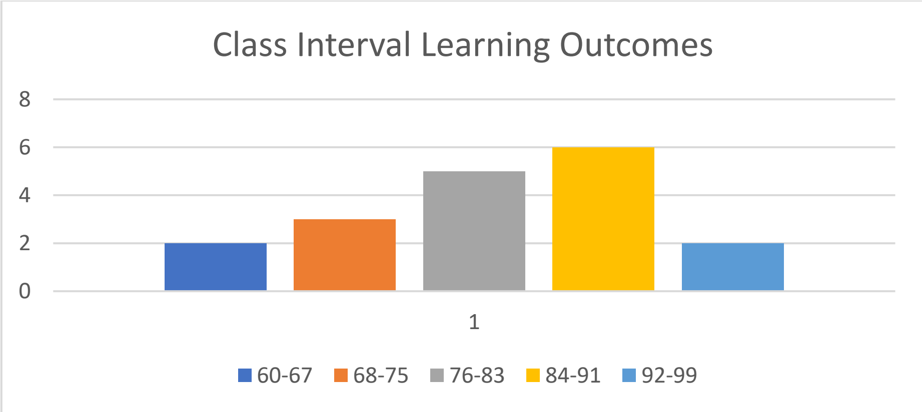

Figure 2. Histogram of control class frequency distribution

Then a range of learning outcomes for experimental class students. The highest frequency achieved in the experimental class was with the 84-90 interval class with 6 students. To illustrate the results more clearly, you can see the figure 3 below

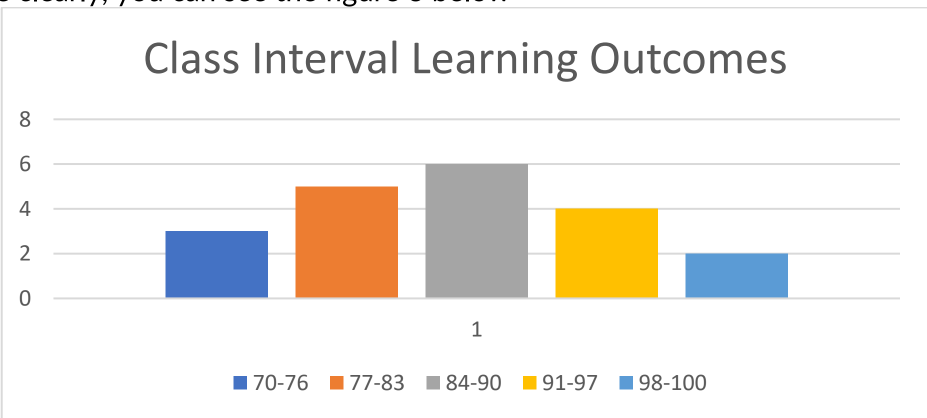

Figure 3. Histogram of experiment class frequency distribution

Next, to find out the average value of students' learning completeness in both classes, you can see table 3 below.

Table 3. Average and percentage of students' learning in the experimental and control class.

Class	The number of students	Mean	The number of students who achieve the minimum completion criteria is 75	Completion Percentage
Experiment	20	85,75	17	85%
Control	18	80,88	11	61,11%

(source of research data)

From table 3. it can be seen that the average completeness of learning outcomes for experimental class students is 85.75 while for the control class is 80.88. The data from the experimental class normsality test results can be seen in table 4 below

Table 4 Normality Test of Learning Results

Variable	Class	Statistic	N	Significant	Information
Learning Outcomes	Experiment	0.22	20	0.393	Normal
	Control	0.159	18	0.187	Normal

(source of research data)

Based on table 4, it can be seen that the data in the experimental class is normally distributed. This is in accordance with the significant criteria for normally distributed data if the sig value is greater than α = 0.05. it can be concluded that posttest data from learning outcomes in the experimental class is normally distributed. Complete calculations for the homogenesis test can be seen in table 5 below

Table 5 Homogenity Test of Learning Results

Information	Based on Mean	Based on Median	Based on Median and with adjusted df	Based on trimmed mean
Learning Outcomes	0. 584	0.199	0.199	0.545
Significant	0.450	0.659	0.659	0.465

(source of research data)

Based on table 5, it can be seen that the Sig value in the experimental class learning outcomes test is greater than 0.05. In accordance with the test criteria, if sig> 0.05 then the sample has a homogeneous variance. Based on this explanation, it can be concluded that the experimental class comes from from a homogeneous population of 0.450. Hypothesis testing uses paired samples t-test with sig (2 tailed) values in the SPSS 16 program test can be seen in table 6 below

Table 6. The research test is in the form of a paired samples t-test

Variable	the number of students	Asummed variances	Samples test for equality of variances		
			T Count	Significant	T Table
Learning Outcomes	38	Equal variances assumed	3.786	0.001	2.028

(source of research data)

Based on table 6 above, the results show that the value of t = 3.786 and the value of Sig. (2-tailed) is worth 0.001. To find out the value of the ttable distribution, it is seen based on df = 36 with a significance level = 0.05, which is 2.028. Because the value of tcount > ttable (3,786 > 2,028) and Sig 2-tailed 0.001 < 0.05, Ho is rejected and Ha is accepted. Thus, it can be concluded that students with Realistic Mathematics learning treatment have better learning outcomes compared to students with learning treatment using the discovery model.

Discussion

In the results of research conducted in electricity classes in basic electricity and electronics subjects, both for experimental classes that use the Realistic Mathematics learning model and control model discovery classes, it can be seen that student learning outcomes have differences between the two. This can be seen in the average learning outcome score for experimental class students of 80.88 while the control score was 78.6. The achievement of different learning outcomes can of course be seen in the teacher's application of the stages of the learning model which are adapted to the basic competencies of basic electricity and electronics subjects. In line with Primadhani (2020) the discovery learning model with realistic mathematics education is effective in terms of interest and mathematics learning outcomes for class V students. This is proven by the differences in learning outcomes using the Independent Samples T-Test showing tcount > ttable (2.035 > 1.994) and significance < 0, 05 (0.027 < 0.05), while the effectiveness test in terms of student learning outcomes using the One Samples T-Test shows tcount > ttable (3.084> 1.691). Likewise, research by Mardiana et al., (2019) shows that there are differences in mathematics learning outcomes in statistical material between students who use the Realistic model and the Expository model. The mathematics learning outcomes of students taught with a realistic mathematical model were 78.6 higher than those taught with an expository model of 71.67 on the subject of statistics.

Furthermore, in line with other research Yunita & Anwar (2020) by implementing the discovery learning model, students can learn actively, while the teacher acts as a guide, because in the learning process of this discovery learning model students are not presented with lessons in final form, but through a process of discovery. Likewise, there are differences in creative thinking between students taught using the Realistic Mathematics Education (RME) learning approach and discovery learning models and students taught using conventional or other methods. This can be seen from the research results obtained, namely $0.3 \leq g < 0.7$ (Ashari et al., 2023). Apart from that, in achieving student learning outcomes using the Realistic Mathematics Education approach, of course the material presented in basic electricity and electronics subjects is very relevant to situations and problems in the real world. In line with research, educators should be able to implement learning that can connect the real world with mathematics learning because this will make it easier for students to solve mathematical problems, and can increase students' interest in learning mathematics. It is proven that the difference in student learning outcomes is better when using realistic mathematics models is higher if compared with the problem-based learning model with the results of the independent sample t-test which produces a sig value. (2-tailed) is $0.001 < 0.05$ (Adi & Koeswanti, 2023).

Then, in implementing this model, you can provide examples of calculating the current flowing in a conductor, the electric charge on the conductor, as well as the calculation results proven by electrical measuring instruments. This helps students understand math concepts better because they see direct application of what they are learning. In addition, it encourages students to engage in active learning activities, such as solving problems, discussing with classmates, and creating mathematical representations. This activity helps students to internalize mathematical concepts better than just listening to the teacher's explanation. On the other hand, there is a deeper understanding when teaching mathematical concepts through the construction of knowledge by the students themselves. This allows students to build a deeper understanding of concepts than simply memorizing formulas or procedures. Realistic mathematics learning (rediscovery) with an ethnomathematics approach can be a vehicle for students to simplify mathematical concepts to make them more meaningful. This activity helps students to internalize mathematical concepts better than just listening to the teacher's explanation. On the other hand, there is a deeper understanding when teaching mathematical concepts through the construction of knowledge by the students themselves. This allows students to build a deeper understanding of concepts than simply memorizing formulas or procedures. Realistic mathematics learning (rediscovery) with an ethnomathematics approach can be a vehicle for students to simplify mathematical concepts to make them more meaningful (Andriani et al., 2020; Herawaty et al., 2020).

In achieving student learning outcomes using the Realistic Mathematics Education approach, of course the material presented in basic electricity and electronics subjects is very relevant to situations and problems in the real world. In line with research from (1) educators should be able to implement learning that can connect the real world with mathematics learning because this will make it easier for students to solve mathematical problems, and can increase students' interest in learning mathematics as proven by differences in student learning outcomes. It is better to use realistic mathematical models. Higher when compared to problem-based learning models. Examples of calculating the current flowing in a conductor, the electric charge on the conductor, as well as the calculation results proven by electrical measuring instruments. This helps students understand math concepts better because they see direct application of what they are learning. In addition, it encourages students to engage in active learning activities, such as solving problems, discussing with classmates, and creating mathematical representations.

This is different from learning with discovery learning, where in the context of basic electricity subjects, there are several adjustments that can be made according to students' abilities, including adjusting the level of difficulty of the material is very important. Basic electrical material can be taught at different levels of depth depending on the student's abilities. Meanwhile, for students who need additional support such as proof through formulas or concrete calculations through visual measuring instruments. There are differences in mathematical communication abilities between students taught using discovery learning models through everyday mathematics and conventional ones after controlling for students' initial abilities; The discovery learning model through everyday mathematics and cognitive style together influence mathematical communication skills.

CONCLUSION

Based on the results of the research and discussions that have been carried out, it can be concluded that student learning outcomes in basic electricity and electronics subjects taught using the Realistic Mathematics Education model with the discovery learning model have different results as seen from the average student learning outcomes. Of course, students' ability to solve problems related to formulas and visualizations in the form of proving measurement results on measuring instruments is better when applying the Realistic Mathematics Education model than the discovery learning model. Therefore, of course teachers need to try to innovate learning models that are adapted to subjects related to mathematical problem solving in the form of calculating electrical formulas in order to create effective and targeted learning. Of course, the teacher's expected achievements in the form of student learning outcomes can be seen from students' understanding in solving cases in the basic learning process of electricity and electronics.

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