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Effectiveness Of Problem Based Learning (PBL) Model Based On Electric Circuit Study (ECS) On Dynamic Electricity Material Towards High School Student Creativity

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Abstract

This study aims to determine: The Effectiveness of the Problem Based Learning (PBL) Model Based on Electric Circuit Study (ECS) on Dynamic Electricity Material on the Creativity of Students of SMA Negeri 1 Siantar. This study design uses a Two Group pretest-posttest design, where the subject is given a pretest, followed by treatment (the use of the ECS virtual laboratory), and then given a posttest. The population of this study is all grade XII of SMA Negeri 1 Siantar, the sampling technique is purposive sampling of class XII-1 as the control class and class XII-2 as the experimental class. The dependent variable is the Effectiveness of the Problem Based Learning (PBL) Model Based on Electric Circuit Study (ECS) and the final variable is Student Creativity. The data collection technique uses a test instrument, the test instrument used is an essay test. The research data were analyzed using an Independent Sample T-test. The results of the Independent Sample T-test <0.05 which stated that the hypothesis was accepted. So it can be concluded that the Problem Based Learning (PBL) learning model based on Electric Circuit Study (ECS) is effective in increasing student creativity.

Keywords : Learning Model, Media, Creativity

INTRODUTION

Education own role important in life something nation And country. As foundation main in development source Power man Which tough And capable face challenge era, education Keep going develop along with progress technology. Development technology has bring change significant in various field, including in world education, like physics. In

learning physics technology has become drng change with introduce method learning new more interactive And easy accessible, like e-learning, application education, And laboratory virtual (Judge, 2024) .

In context learning, technology shift paradigm from method conventional to approach based digital. Student now can access various source Study like video learning, simulation interactive, And platform online. Technology Also drng learning Which personal And flexible, allows student Study in accordance style And its speed each. However, according to UNESCO (2020), implementation technology in sector education Still face constraint, especially in area with limitations infrastructure, training Teacher, And access device (Yahya, 2023).

Wrong One model learning Which can used is Model Learning *Problem Based learning* (PBL). According to (Richard Arends, (2013) Model *Problem Based learning* (PBL) based on on principle problem as point beginning acquisition And integration knowledge new. Model This demand participant educate involved active in activity investigation For build knowledge Alone And use skills cognitive solve problem life real. (Yahya, 2023) add that Model Learning *Problem Based Learning* (PBL) potential grow flavor want to know student through experiment, Investigation in the form of experiment can served in program computer so that participant educate can explain And presenting learning they.

Program computer in learning physics is laboratory virtual. According to (Yahya, 2023) Model Learning *Problem Based Learning* based Laboratory virtual potential increase creativity And interest Study student. Will but, utilization laboratory in SENIOR HIGH SCHOOL Country 1 Siantar Still Not yet optimal. Based on observation researchers (04/09/2025), equipment laboratory physics in school the Still minimal. Besides That, understanding Teacher to use variation media learning Also Still low. Condition This cause learning become fed up And boring, as well as impact on low creativity And results Study student, specifically in visualize concept physics in a way kncrete (Vera, Yulia, & Rusliah, 2021).

Limitations tool practical work Also become obstacle main in implementation practice series electricity. Matter This worsened leh dominance method lecture Which Still used Teacher physics. Method learning Which not enough varied the impact direct on achievements on achievements academic student. Based on data mark daily student class XII-4 Science SENIOR HIGH SCHOOL Country 1 Siantar Year Teachings 2024/2025, known that 70% from 25 student get mark in lower Minimum Competency (KKM) And 30% from 11 is at in on KKM, condition This show that learning in class the Not yet walk effective.

For answer challenge the, Researchers offer utilization Model *Problem Based learning* (PBL) based *Electric Circuit Studies (ECS)* as solution. *Electric Circuit Studies (ECS)* is Wrong One laboratory virtual Which offer solution practical. *Electric Circuit Studies (ECS)* allows student designing And analyze series electricity without depends on tool physique. (Hasanah, (2021) show that *Electric Circuit Studies (ECS)* support simulation real-time For observe parameter like voltage And obstacle. Platform This provide mde simulation DC, AIR CONDITIONING, And transient, as well as tool measuring virtual like ammeter, voltmeter, And silskp. More carry on (Suari et al, (2021) confirm that Features on *Electric Circuit Studies*

(ECS) make things easier student in experiment, count parameter electricity based on law hm, as well as visualize results in form text and chart. (Meilina et al, 2023) conclude that *Electric Circuit Studies (ECS)* drng exploration series new, practice analysis, And develop thinking critical studentN(Wau, 2017).

Besides support understanding concept, *Electric Circuit Studies (ECS)* Also grow creativity student. Creativity in study This based on on Anchovies Tranquility (1974) Which develop concept think divergent from guildrd (1967). through approach anchovies Tranquility (Kasmawati et al, (2021) identify indicator creativity consists of from smoothness, flexibility, authenticity, And elaboration. (Blessed et al, 2022) say, anchovies creativity Tranquility describe capacity individual in finish problem in a way risinal And innovative. (Putu Widiarini, 2022) conclude that laboratory virtual capable increase creativity Student, Media This give freedom for student For designing, modify, And explore ideas new in a way safe And interactive so that bring up solution risinal And innovative in learning science.

Based on problem And solution Which has described, researchers do study with title: "Effectiveness Model Learning *Problem Based Learning* (PBL) based *Electric Circuit Studies (ECS)* On Material Electricity Dynamic To Creativity Student SENIOR HIGH SCHOOL Country 1 Siantar". Prpsal thesis This expected can serve data Which clear about benefit laboratory virtual in increase creativity student, as well as offer solution practical For overcome limitations learning physics in school.

RESEARCH METHODS

Type study This is quantitative with approach experiment pseudo (*quasi experimental design*). Design study Which used is *Tw Group pretest-psttest design* , in where subject given pretest, to be continued with treatment (use laboratory virtual ECS), And Then given psttest.

Study This done in SENIOR HIGH SCHOOL Country 1 Siantar on semester odd year teachings 2025/2026. Election location This based on on consideration accessibility, availability facility, And suitability curriculum (Farida, Hasanudin, & Suryadinata, 2019).

Design study Which done is *Tw Group pretest-psttest design* , Reason use *Tw Group pretest-psttest design* Because objective comparison something consequence treatment certain with something treatment Which different. in researchers This involved two class Which compared to, that is class experiment And class kntrl. One class that is class experiment given treatment Model *Problem Based Learning* (PBL) based *Electric Circuit Studies (ECS),* whereas class kntrl use model learning conventional. Design study This can seen on table 3.3 as following: Technique taking sample Which used in study This is *purposive sampling*. Student

class XII-1 as class kntrl Which amount to 34 rank And class XII-4 as class experiment Which amount to 36 rank.

On researchers This, there is two variables that is Variables free (X) And variables bound (Y), Variables free And variables bound That as following:

a. Variables free/ *independent* (X) : Model Learning *Problem Based Learning* based Laboratory Virtual *Electric Circuit Studies (ECS)*
b. Variables Bound/ *dependent* (Y): Creativity Student SENIOR HIGH SCHOOL 1 Siantar.

Effectiveness Model Learning *Problem Based Learning* based *Electric Circuit Studies* is ability model learning increase understanding concept electricity dynamic And creativity student through simulation interactive *Electric Circuit Study* . According to (Yahya, 2023) Model Learning *Problem Based Learning* based Laboratory virtual potential increase creativity And interest Study student. More carry on (Hasanah, 2021) , say that ECS allows student do experiment in a way real-time with tool measuring virtual like voltmeter And ammeter. In a way teritis, (Alexander, (2013) state that understanding connection between current, voltage, And obstacle very depends on experience visual And explorative, Which can facilitated in a way effective through media digital like ECS (Malmia et al., 2019).

Creativity in study This referring to on opinion (Trrance, 2019) . According to (Trrance, (2019) creativity that is ability For produce something configuration new from element Which has There is, Which will grow optimal in environment Study Which drng exploration And freedom think. Creativity student measured based on indicator smoothness, flexibility, authenticity, And elaboration (Kasmawati, (2021)

Test hypothesis done For evaluate Effectiveness Model *Problem Based Learning* (PBL) based *Electric Circuit Studies* (ECS) on material electricity dynamic to creativity student in SENIOR HIGH SCHOOL Country 1 Siantar. For test hypothesis, used test "t" through program software *IBM SPSS Statistics 22* . Criteria testing hypothesis is as following:

1. If mark significance (*2-tailed*) < 0.05, so Hypothesis accepted, It means there is difference Which significant.
2. If mark significance (*2-tailed*) < 0.05 so Hypothesis rejected or No there is difference Which significant.

RESULTS AND DISCUSSION

Results research This will answer formulation problem Which has made And Also determine hypothesis accepted or rejected. Sample Which used as much as 36 student on class experiment, class the that is XII Science-4 And 36 student For class kntrl that is class XII Science-1. Data study obtained from sheet observation implementation activity teach Teacher / researchers And from results Study physics student Which in the form of mark *pretest* And *psttest* , before get mark *pretest* And *psttest* instrument salt validated moreover formerly to two validatr that is dsen physics UHKBPNP And Teacher eye lesson physics JUNIOR HIGH SCHOOL Love People 1 Pematangsiantar, Then For instrument questionnaire creativity student, researchers validate 10 instrument questionnaire creativity student to dsen mentor I.

Study This implemented as much as 3 meeting on group experiment during and group kntl. Meeting First done *pretest* 2× 45 minute in class kntrl (XII Science-1) And class experiment (XII-4). On meeting second researchers do treatment use model learning *Problem Based Learning* (PBL) in class experiment And in class kntrl using model learning conventional, on meeting third researchers do test end (*psttest*) on class experiment And kntrl. Based on results Which in test *SPSS 22,* results Study physics student class experiment (XII Science-4) before given treatment (*pretest*) own mark lowest The lowest value is 30 and the highest value is 61, the average value is 44.36 and the standard deviation is 7.533. Meanwhile, after being given treatment (*psttest*), the lowest value is 76, the highest value is 92, the average value of the *psttest* is 84.94 and the standard deviation is 4.591 (Pratiwi, Margunayasa, & Trisna, 2023). On analysis the seen improvement mark creativity student on process learning use *Problem Based Learning* based *Electric Circuit Studies* on material electricity dynamic. From the explanation above, the students' physics learning outcomes before treatment were 44.36 then increased to 84.94. Next, results Study student in class kntrl (XII Science-1) Before being given treatment (*pretest*), the lowest score was 28 and the highest score was 61, the average score was 39.13 and the standard deviation was 7.48. Meanwhile, after being given treatment (*posttest*), the lowest score was 70, the highest score was 92, the average *posttest score* was 77.66 and the standard deviation was 6.07. For discussion furthermore will described results study in the form of analysis data activity researcher And results Study cognitive physics student on class experiment And class kntrl. Analysis the that is: Test Validity And Test Reliability, Test Normality, Test Humanity, Test Hypothesis (*T test*). Test instrument done For know as far as where quality study with count test validity And test reliability. Instrument study Which used moreover formerly validated leh for expert (*expert judgment*) before implemented in field. Validation This aim For ensure that grains instrument in accordance with indicator, worthy used, as well as capable measure aspect Which targeted. Instrument test results Study validated leh two validatr Which own background behind in accordance field study. Validatr First is Dr. April Bernard Simamra, S.Pd., M.Pd., dsen Program Studies Education Science University HKBP Nmensen Pematangsiantar Which expert in field education science. Validatr second is Ardn Symbol, S.Pd., Teacher Physics in JUNIOR HIGH SCHOOL Love People 1 Pematangsiantar Which experienced in teach at a time evaluate student (Wahyuni, Fauziah, Aisyah, & Al-Fayed, 2023). Second validatr evaluate instrument based on suitability with indicator realm cognitive C4–C6 in accordance Taxnmi Not yet revision.

Hypothesis Testing

The hypothesis test was conducted to assess the effectiveness of *the Electric Circuit Study (ECS*)-based *Problem Based Learning (PBL) model on dynamic electricity material on student creativity at SMA Negeri 1 Siantar. To test the hypothesis, a "t" test was used through the IBM SPSS Statistics 22* software program . According to (Hartn, 2020) the criteria for hypothesis testing are as follows:

1. If the significance value (*2-tailed*) < 0.05, then the hypothesis is accepted, meaning there is a significant difference.
2. If the significance value (*2-tailed*) < 0.05 then the hypothesis is rejected or there is no significant difference.

The statistical hypothesis in this study is formulated as follows:

(H 0): There is no effectiveness of the *Problem Based Learning* (PBL) Model based on *Electric Circuit Study* (ECS) on Dynamic Electricity Material on the Creativity of Students of SMA Negeri 1 Siantar.

(H $_a$): There is an Effectiveness of the *Problem Based Learning* (PBL) Model Based on *Electric Circuit Study* (ECS) on Dynamic Electricity Material on the Creativity of Students of SMA Negeri 1 Siantar.

After calculations were carried out with the help of the *SPSS 31 computer program* , the data obtained were as in the following table:

Table 1. Hypothesis Testing

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Hasil	Equal variances assumed	.595	.443	-5.732	70	.000	-7.444	1.299	-10.035	-4.854
	Equal variances not assumed			-5.732	66.888	.000	-7.444	1.299	-10.037	-4.852

Based on the table above, the significance value (*2-tailed*) is 0.000 < 0.05 , so it can be concluded that there is effectiveness of the *Problem Based Learning (PBL) learning model* based on *Electric Circuit Study* (ECS) on Student Creativity.

Discussion

The effectiveness of *the Problem Based Learning* (PBL) learning model based on *Electric Circuit Study* (ECS) On the Material of Dynamic Electricity on the Creativity of SMA 1 Siantar Students

Based on the results of data analysis, the hypothesis in the study was declared accepted. This means that the use of the *Problem Based Learning* (PBL) learning model based on *Electric Circuit Study* (ECS) has proven effective in increasing student creativity in dynamic electricity material at SMA 1 Siantar. This can be seen from the difference in the average results of the pretest and posttest scores in the experimental class. Before the treatment, the average student score was only 59.91 , which indicates that their understanding was still limited. However, after the *Problem Based Learning* (PBL) learning model based on *Electric Circuit Study* (ECS) was applied, the average score increased sharply to 80.9 . This result can be seen in the histogram below, where the pretest bar appears much

lower than the posttest, as if depicting a significant "step" in understanding (Darllis, F, & Miaz, 2020).

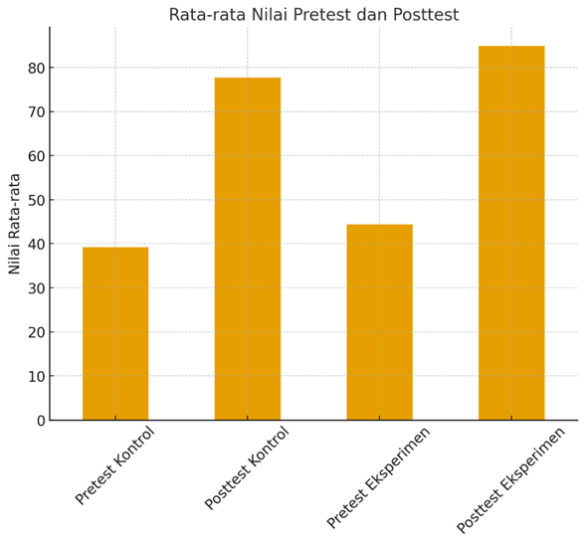

Figure 1. Histogram comparing pretest and posttest scores for the KNTL class and the experimental class.

In addition to test results, increased creativity was also evident from student questionnaires. In the experimental class, the highest score (8 students) was 95, while the lowest score (2 students) was 82 (Simanjuntak, Thesalonika, & Sihombing, 2024). The range of creativity scores for grades XII-4 students was between 80 and 97. The results showed that the use of the *Problem Based Learning* (PBL) learning model based on *Electric Circuit Study* (ECS) was able to encourage students to be more active and creative in finding solutions. The results can be seen in the following histogram (Alfianiawati, Desyandri, & Nasrul, 2019):

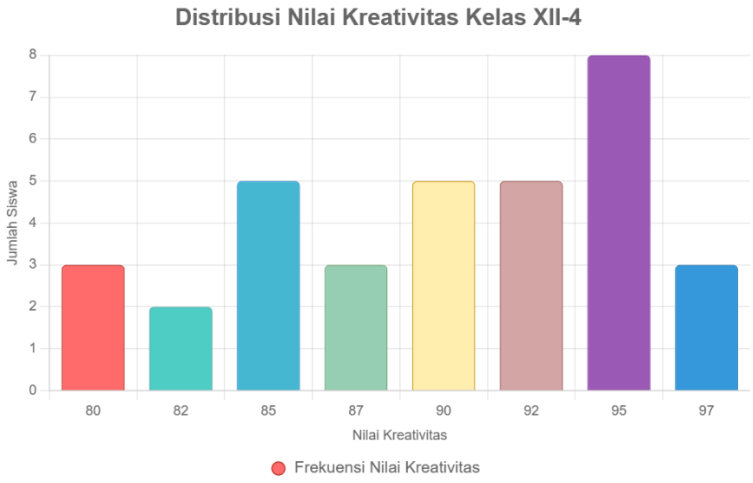

Figure 2. Histogram of creativity of XII-4 students

Then in class XII-1 as the central class of creativity scores. The graph below illustrates the distribution of creativity scores of class XII-1 students based on their frequency of occurrence. A score of 95 recorded the highest frequency, achieved by seven students, while scores of 75 and 88 were each only obtained by one student, making them the scores with the lowest frequency (Kurnia & Mukhlis, 2023). The range of creativity scores of class XII-1 students is in the range of 75 to 98. The results can be seen in the following Instagram:

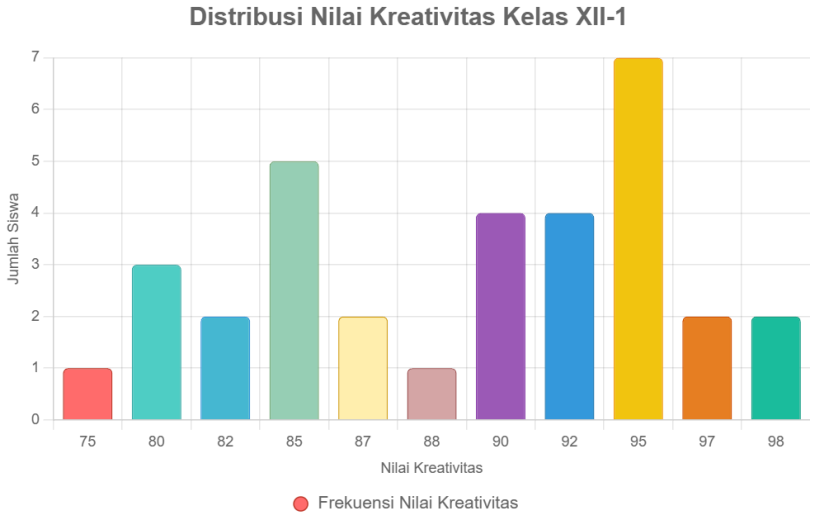

Figure 3. Histogram of creativity scores of XII-4 students

Thus, the histograms displayed for both the pretest and posttest, and student creativity scores, all show similar results: the *Problem Based Learning* (PBL) model based on *Electric Circuit Study* (ECS) is able to provide a more meaningful learning experience, improve conceptual understanding, and foster creativity. This finding is in line with research by Hasanah (2021) and Meilina (2023) , which emphasizes that interactive simulation media provides more space for teachers and students to innovate, without being trapped in conventional learning models that limit learning (Fannisa, Anggraini, Romdani, & Dewi, 2023).

Results of the implementation of the *Problem Based Learning* (PBL) Learning Model

Based on the results of observations conducted by the observer on the researcher's teaching activities, where each implementation sheet consists of 13 activity psi in the first and second meetings. Each psi has the highest value of 4, the activity psi is in accordance with the indicators of the *Problem Based Learning (PBL) learning model. The results of the implementation of the researcher's teaching activities with the syntax of the Problem Based Learning (PBL)* learning model can be seen in table 4.4.1 below:

Table 1. Results of the Implementation of the *Problem Based Learning* (PBL) Learning Model

Syntax	Activity	Meeting		Category
		I	II	
Introduction	Teacher Says Greetings	**4**	**4**	Very good
	Berda	**4**	**4**	Very good
	Explain the learning objectives and activities to be carried out.	**2**	**4**	Good
	Giving *a pretest* (meeting I)	**4**	**4**	Very good
Directing Students to the Problem	The teacher presents a contextual problem related to dynamic electricity, presented in a simulation using the ECS Virtual Laboratory. Students observe the problem description, either in text, video, or an interactive display from the ECS.	**3**	**4**	Good
	Students ask and answer questions with the teacher	**4**	**3**	Good
Preparing Students to Learn	The teacher directs students to understand the problem individually and prepare themselves to conduct independent investigations through ECS simulations.	**3**	**4**	Good
	The teacher gives LKPD to students	**4**	**4**	Very good

Syntax	Activity	Meeting		Category
		I	II	
Assisting Independent Investigations	The teacher explains the LKPD that the students received	**3**	**3**	Good
	Students conduct experiments individually, record observations, and interpret data.	**4**	**3**	Good
Developing and Presenting Results	The teacher guides students in compiling individual reports on the results of experiments.	**3**	**4**	Good
Analyzing and Evaluating the Problem Solving Process	The teacher evaluates the effectiveness of learning based on the results of student investigations and presentations.	**4**	**3**	Good
	Students do reflection	**4**	**3**	Good
Closing	The teacher gives a posttest	**4**	**4**	Very good
Total		**3.84%**	**3.92%**	**Very good**

In the table above, the percentage of the number of researcher teaching activity implementation sheets at meeting I was 3.84% (very good) and meeting II was 3.92% (very good). The average implementation reached 3.92% with very good criteria. This shows that H is rejected and Ha is accepted (Garg, Kumar, & Garg, 2019). Therefore, the Problem Based Learning model based on *Electric Circuit Study* (ECS) can provide opportunities for students to be more active in learning, both in discussions and exchanging arguments, especially in scientific work procedures (Siswadi, Saragih, & Wardana, 2023).

CONCLUSION

Based on results analysis data And discussion can concluded that:

1. Model *Problem Based Learning* (PBL) based Electric Circuit Studies (ECS) proven effective increase creativity student. Results test hypothesis show mark significance (*2-tailed*) is 0,000 < 0.05 Number This become proof approach *Problem Based Learning* based *Electric Circuit Studies* capable change dynamics class: student Which back to the

beginning passive now more brave put forward idea, try design series, until find solution unique in learning electricity dynamic.

2. Response positive come No only from student, but Also from Teacher. Teacher Which previously restricted leh limitations laboratory real now find *Electric Circuit Studies* as "laboratory second" Which practical And safe. For student, *Electric Circuit Studies* become room play at a time study – place in where error No make Afraid, but bring up idea new. This is it proof that technology, when combined with model learning Which appropriate, can grow creativity at a time bridge limitations facility school.

Suggestion

Based on results research, researchers recommend:

1. **For Teacher physics.** *Electric Circuit Studies* should integrated in a way systematic to in model *Problem Based Learning* (PBL). With so, Teacher No only convey concept electricity dynamic in a way teritis, but Also guide student For develop creativity, think critical, And finish problem real through simulation interactive.
2. **For Reader.** *Electric Circuit Studies* Don't only viewed as application simulation normal. He Can become room Study Which safe For experiment, try various idea, And find solution new. With take advantage of it in a way maximum, student can grow flavor want to know, creativity, as well as courage invade in Study physics.
3. **For researchers furthermore.** Study This Still limited on material electricity dynamic. Researchers next can expand study on tpik physics other or research influence *Electric Circuit Studies* to aspect different, like motivation Study, skills think critical, or ability clabration. With thus, potential *Electric Circuit Studies* as media learning modern will the more tested And develop

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