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The Effect of E-Module on Activity and Learning Outcomes on Electrolyte and Nonelectrolyte Solutions

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***Abstract*:** *This study aims to determine the increase in activity, learning outcomes and the relationship of activity with student learning outcomes with the Project Based Learning (PjBL) learning model assisted by class X high school e-modules on electrolyte and nonelectrolyte solution materials. The study population was 6 classes (216 students) in class X IPA SMAN Rantauprapat, with random sampling techniques obtained in 2 classes (experimental and control class). This study used test and non-test instruments observation sheets of student learning activities that have been tested and valid. The data obtained are tested for normality and homogeneity. The results obtained are in the form of learning results tcount = 9.714 and ttable = 1.66, activities obtained tcalculate = 6.069 and ttable = 1.66. Where thit>ttable that Ha is accepted and H0 is rejected so that it is concluded that there is an influence of the PJBL model assisted by class X SMA e-module on electrolyte and nonelectrolyte solution materials. The correlation test obtained the result that rcalculate > rtable (0.929 > 0.329) then H0 is rejected. There is a significant correlation between activities and learning outcomes of students assisted by class X high school e-modules on electrolyte and nonelectrolyte solution materials.*

***Keywords*:** *Project Based Learning; E-module; Student Learning Activity; Electrolyte and Nonelectrolyte Solutions.*

INTRODUCTION

Science is a part of Inherent Sciences (IPA) that explicitly concentrates on the construction, piece, properties, and changes in issue, as well as the energy that goes with material changes. Chemistry is a compulsory subject for students majoring in Natural Sciences, this does not rule out the possibility of difficulties in following their learning. In addition, in general, students assume that chemistry subjects are complex so that students feel bored studying them, as a result not a few students are less or even not interested in understanding and mastering the basic concepts of chemical matter (Rostika, 2020).

One of the materials that is considered difficult is electrolyte and non-electrolyte solution materials. This material is difficult because it has characteristics, including requiring accuracy in deducing the symptoms

of conduction of electric current in various solutions, grouping solutions into electrolyte and non-electrolyte solutions based on the type of bond and being required to memorize the number of solutions according to their types theoretically (Utami et al., 2009). Logically, electrolyte and non-electrolyte solutions are also difficult because using mathematical calculation skills that some students consider to be difficult. This material requires a high understanding of concepts and strong memorization as well as real and applicable learning experiences. Students consider chemistry to be theoretical, abstract and logic is difficult material (Sihombing & Sitorus, 2022).

In view of the aftereffects of perceptions and meetings with one of the science educators at SMA 1 Rantau Utara, it is known that the chemistry teacher at the school still teaches using the lecture method. The lack of maximum learning outcomes is also caused by the lack of harmony between the learning model used and the methods and media used. This shows that the growing experience is still educator focused. Students are less involved in the learning process and still achieve low learning outcomes because the classroom learning process emphasizes the ability of students to listen to and record teacher-provided content. In addition, the low interest in learning is due to the fact that many students do not have the courage to express their ideas and new ideas, and the absence of a spot to communicate and contend as per the innovativeness of every kid. So that in learning exercises important to make imaginative learning exercises are fun and urge youngsters to have the option to communicate innovativeness and can further develop understudy learning results. Low student interest in learning results in unsatisfactory grades. This is known from the results of student exams where there are still some students whose scores are below the Minimum Completion Criteria (KKM). KKM for chemistry subjects at SMA Negeri 1 Rantauprapat is 75. Most students consider that chemistry subjects are difficult, complex and abstract. They claimed that it was easier to understand chemistry through practicum activities. This is because chemistry learning becomes more real.

LITERATURE REVIEW

a. Study Results

Learning Results are the result of a learning. Learning results are defined as the basis for assessing and reporting student learning achievements, as well as to develop more effective learning methods and have a match between the material studied and how students are assessed. Learning results are also one of the benchmarks in learning achievement indicated to the extent of achievement of students, educators, learning processes, and educational institutions in an effort to achieve educational goals (Andini & Azizah, 2021).

Students learning outcomes are influenced by several factors. The influencing factors according to Slameto are as follows:

1. Internal factors are factors that come from within the individual himself. Internal factors consist of two factors, namely: physical, psychological and fatigue factors
2. External factors are factors that come from outside the individual himself. External factors include family factors, school factors and community factors (Sappaile et al., 2021).

b. Student Learning Activitie

Learning activity is an activity carried out by students during the learning process to achieve learning outcomes. To achieve optimal learning results in learning, it is necessary to emphasize the existence of student activities both physically, mentally, intellectually, and emotionally (Sinaga & Silaban, 2020). Learning activities are physical and mental activities. In the learning process, the two activities must be related to each other so that maximum results are obtained. Learning activities are also a whole series of activities or activities consciously carried out by a person that causes changes in himself, in the form of changes in knowledge

that depend on the number of changes (Eliyasni, 2019).

According to Paul B. Diedrich in the book (Sardiman, 2016) made a list containing 177 kinds of student activities which among others can be classified as follows: visual activities, oral activities, listening activities, writing activities, drawing activities, motor activities, motor activities, mental activities and emotional activities.

c. Model Project Based Learning

One of the learning strategies that is considered to change the abstractness in chemistry learning is Project-Based Instruction. PjBL Model is a methodical advancing by including understudies to look for data and information in light of genuine encounters to deliver items. The PjBL Learning Model has qualities that expect understudies to go with choices through an efficient structure, have issues whose arrangements are not restricted and expect understudies to plan the action cycl . PjBL offers understudies the chance to learn and work together to solve a problem and then present their work to an audience. Students are actively involved during the time spent issue definition, critical thinking, decision making and other activities (Jalinus et al., 2017).

Project Based Learning model (PjBL) is an oriented learning model so that students can learn independently in solving problems that are being faced so that they can produce a project or real work (Prabawati & Agustika, 2020). The use of appropriate models can involve active students to think and develop knowledge, providing support and opportunities for students to develop their ideas. PjBL model is closely related to the scientific approach, because the scientific approach is the spearhead that integrates the science of learning both starting from the emergence of problems (Marpaung & Suyanti, 2023).

PjBL is a challenging yet effective method for science students, immersing them in real world applications of theories, particularly in chemical analysis. Successfully used in science education, especially in teaching chemistry, this approach cultivates skills like problem solving, investigation, and discovery (Simalango & Situmorang, 2024).

Project Based learning (PjBL) is a learning model that offers teachers the opportunity to conduct face-to-face classes through project work. This PjBL is based on constructivist learning theory, based on the idea that students construct their own knowledge in the context of their own experiences. Building knowledge means giving freedom to students to explore knowledge and make efforts to build from the experience gained. This PjBL can make students more active and motivated to participate in the learning process (Purba & Sembiring, 2023).

The advantages of the PjBL model stated by McDonell (Sujana et al., 2020) are that the model is ready to work on the capacity to get clarification on pressing issues, look for data and decipher the data they see, hear, or read. As well as making research arrangements, recording discoveries, discussing, examining, and simply deciding as well as working to display and construct information independently. The syntax of the project-based learning model consists of 1) determination of project-based themes by teachers and students, 2) visualization of student group work, 3) observation and identification of various problems, 4) preparation of project proposals, 5) production processes, 6) assessment of processes or products and feedback on student work methods, and 7) presentation of project reports (Syahril et al., 2020).

d. E-modules

The educational experience will run well whenever upheld by the availability of adequate teaching and learning resources, interesting media, and the right learning system. One of the endeavors to remind the growing experience is by expanding the utilization of showing material media which effectively enhances the quality ultimately improving the quality of learning outcomes

for the better (Nurrita, 2018). One of the efforts is the use appropriate and careful teaching materials according to the needs of the era in the 4.0 era which until now is still able to survive and compete with other teaching materials, namely by using modules. Module is a tool that becomes one of the means of education in learning in which there are materials, methods, and evaluations that are made systematically, arranged, and structured as an effort to achieve the expected competency goals. Modules are specifically designed and very clear according to the speed of understanding of each student so that it can encourage teaching and learning systems according to the level of ability of each student. Along with technological developments, there is a combination of print media and computer media in the teaching and learning system (Sidiq & Najuah, 2020). One of them is included in this case with a module that transforms the presentation in the form of electronic media that is capable and can be accessed anywhere with good effectiveness so that it gives birth to using the term e- module or commonly referred to electronic module (Winatha et al., 2018).

Electronic modules are learning packages required for learning a specific subject that permits understudies to concentrate freely furnished with video, sound, reenactments, tests, and so on. Electronic modules are learning materials that are deliberately planned 15 in view of a specific educational program and bundled as specific units of time that are shown utilizing electronic gadgets like Pcs or android. Electronic modules are learning instruments or offices that contain material, strategies, cutoff points, and approaches to assessing which are planned methodically and strangely to accomplish the normal abilities as per the degree of intricacy electronically (Marto, 2021).

e. Electrolyte and Non Electrolyte Solutions

Solutes have two properties based on their behavior when electric current is flowed. The first property, solutes can conduct electric current, so that the solution formed undergoes chemical changes and is able to conduct electric current. The solution is called electrolyte solution. The second property, a substance that when dissolved in water cannot conduct electric current and there is no chemical change, so the solution in the form is called a non-electrolyte solution. All inorganic solutions, both acids, bases, and salts have the property of being able to conduct electric current. While all solutions derived from organic substances such as cane sugar, mannose, glucose, glycerin, ethanol, and urea are not able to conduct electric-current. Electrolyte solution is a solution that can conduct electric current, such as kitchen salt solution, sodium hydroxide, hydrogen chloride, ammonia, and vinegar and Nonelectrolyte solution is a solution that does not conduct electric current, such as distilled water, sugar solutions, and alcohol (Watoni, 2013).

Based on the strength and weak electrical conductivity, electrolyte solutions can be grouped into two, namely:

1. Strong electrolyte solution, which is an electrolyte solution that undergoes complete ionization. Observation indicator: the light is bright and gas bubbles appear on the electrode. Example: H_2SO_4 solution, NaOH solution, and NaCl solution.
2. Weak electrolyte solution, which is an electrolyte solution that undergoes little ionization (imperfect ion). Observation indicator: the light does not turn on or lights up dimly and gas bubbles appear on the electrode. Example: CH_3COOH solution and NH_2OH solution

If electrolyte solutions, such as NaCI, HCI, and H_2SO_4 are dissolved in water, the compounds will be ionized. The presence of ions in the solution causes the electrolyte solution to conduct electricity. When the substance dissolves in water, the ions that are initially strongly bound in the solid will be released and float in the solution, between one ion and the other ions are free from each other.

Free-moving ions will go to charged rods (electrodes). Positive ions will go to the negative electrode, while negative ions will go to positive electrodes. In addition to being in the form of a solution, ion compounds in the form of melts can also conduct electricity. When it melts, the ionic compound will decompose into its free-moving ions. As for the ionic compound solids do not conduct electricity because the ions that make them up cannot be decomposed. In solid form, ions cannot move freely (Muchtaridi & Justiana, 2007).

METHODS

This exploration was done at SMA Negeri 1 Rantauprapat, Padang Matinggi, Rantau Utara Locale, North Sumatra Territory. This exploration was completed in class X, Even Semester, 2023/2024 scholastic year with electrolyte and non-electrolyte arrangements as material.

The example in this study was taken utilizing a purposive testing method. Where the example is two classes educated by guides, a similar course reading and strategy. Different treatment is given to each class. The class that was given learning treatment with the PJBL model helped by E-module was class X-MIA1 (X) as the trial class and the class that was given learning treatment with the PJBL model assisted by PPT was class X MIA^{5} (Y).

Because not all variables and experimental conditions can be strictly controlled, this research is quasi-experimental. This semi trial research expects to uncover circumstances and logical results connections by including a benchmark group notwithstanding the exploratory gathering. The examination configuration utilized in this review was pretest-posttest control. The control class and the experimental class received two distinct treatments in this study. The trial class is shown utilizing the PjBL model helped by E-module, while the control class utilizes the PjBL model helped by Powerpoint. Test and non-test instruments are the data research instruments used in this study. Test instruments are utilized to quantify understudy learning results, while non-test instruments are utilized to evaluate understudy learning exercises during the growing experience.

The test instruments utilized in this review were understudy learning results tests as pretests and posttests. The test instrument was given two times, specifically toward the start of the gathering and toward the finish of the gathering. The underlying test (prestest) is utilized to decide the abilities to underlying of understudies in the control class and exploratory class, while the last test (posttest) is utilized to decide understudy learning results in the wake of getting different treatment. The instrument for evaluating understudy learning results is ready as 40 various decision inquiries prior to being approved. The inquiries were then approved with master speakers and a preliminary was done on class.

RESULT AND DISCUSSION

1. Pretest and Posttest Data

a. Pretest Data

Before giving different treatments to the two samples, a pretest was first given to determine the ability / initial knowledge of each student in the two classes about electrolyte and non-electrolyte solution material. Table 1 displays the pretest data from both the experimental and control classes.

Table 1. Pretest Data

	Experiment Class	**Control Class**
Minimum Value	20	20
Maximum Value	50	45
Average	36,35	32,08
Standard Deviation	7,11	6,80
Variance	50,54	46,25

A graph illustrating the average student posttest results for the experimental and control classes can be seen in Figure 1

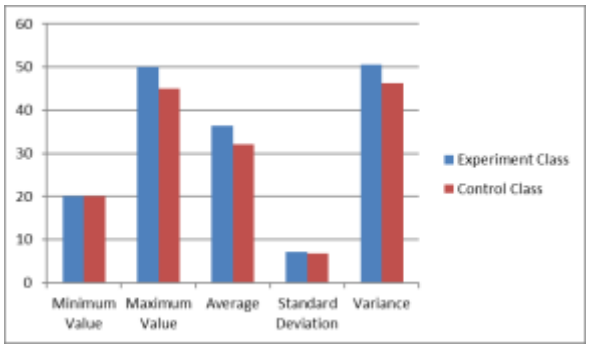

Figure 1. Graph of The Average Value of Student Pretest Data

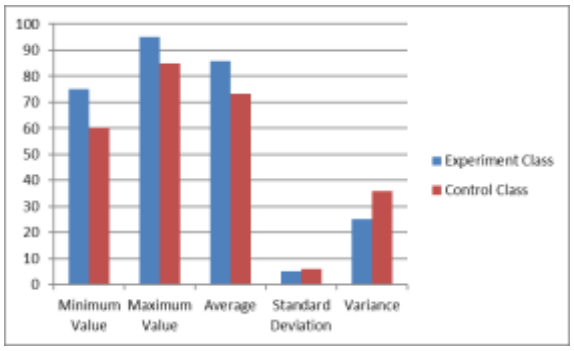

Figure 2. Graph of the average value of student posttest result

It is known from the preceding data that there is not much of a difference in the average scores of students' pretest learning results. The exploratory class acquired a normal pretest score of 36.34 and the control class got a typical learning result score of 32.08. Because of this, it is possible to draw the conclusion that the students' initial abilities were nearly identical prior to receiving treatment.

b. Posttest Data

At the end of the study, the two samples that had been given different treatments, namely the trial class utilizing the PjBL model helped by e-modules while the control class used the PjBL model assisted by powerpoint. Both classes were given a final test in the form of a posttest to measure student learning outcomes. The posttest data obtained from the trial class and control class should be visible in table 2 underneath.

Table 2. Posttest Data

	Experiment Class	Control Class
Minimum Value	75	60
Maximum Value	95	85
Average	85,83	73,19
Standard Deviation	5,00	5,99
Variance	25,00	35,93

A graph illustrating the average student posttest results for the experimental and control classes can be seen in Figure 2.

After students in the trial class were given picking up utilizing the PjBL learning model helped by e-modules, the typical score was 85.83 while the control class was given getting the hang of utilizing the PjBL learning model assisted by powerpoint, the average score was 73.19. In this manner it very well may be presumed that there is a tremendous contrast in the normal score after the two classes are given different treatments.

2. Data Analysis of Student Learning Activities

The estimation results can be straightforwardly acquired from the typical decisive reasoning and coordinated effort scores got by understudies for each class (exploratory class and control class). Evaluation is done in view of the current rubric as in the connection. The introduction of this information should be visible in table 3 underneath:

Table 3. Student Activity Assessment Results

Class	Student Learning Activities		
	$\bar{x}$	S	S^2
Experiment	81,41	6,18	37,96
Control	72,08	7,01	47,16

In view of table 3, it tends to be seen the normal understudy learning action between the two classes given different treatment. In the trial class showed utilizing the Undertaking Based Learning (PjBL) learning model with E-module, the typical understudy learning movement was 81.41. In contrast, the average number of learning activities completed by students in the control class, which utilized PowerPoint and the

Project Based Learning (PjBL) learning model, was 72.08. So it very well may be reasoned that there is an impact of picking up utilizing the Undertaking Based Learning (PjBL) learning model with E-modules on understudies' electrolyte and non-electrolyte arrangement learning exercises.

Student learning activities can be presented in the bar diagram in Figure 3 below.

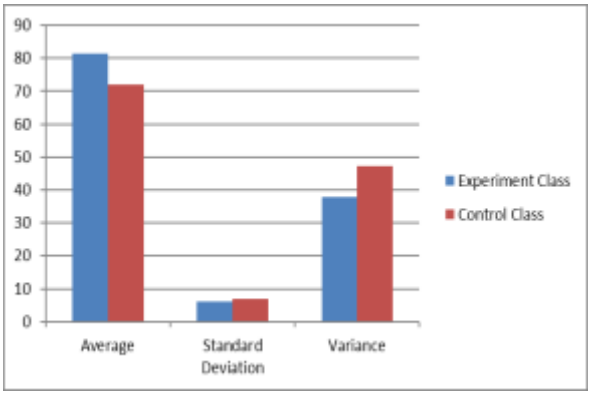

Figure 3. Bar Diagram of Student Learning Activities

After students in the trial class were given picking up utilizing the Venture Based Learning model with E-modules, the typical movement esteem was 81.41, while the control class was given getting the hang of utilizing the Undertaking Based Learning model with powerpoint, the average activity value was 72.08.

3. Research Data Analysis

a. Normality Test of Learning Result Data

Information on understudy learning results were investigated utilizing an uneven t test, to be specific the right-sided t test. Prerequisite tests, such as the normality and homogeneity tests, are carried out first before the data are subjected to the t test. Test prerequisites for information examination incorporate pretest and posttest information ordinariness tests and pretest and posttest information homogeneity tests. Information ordinariness testing was completed utilizing the Chi-Square test, it was found that the pretest and posttest scores for both example bunches had typical information or (X^2)count <(X^2)table at an importance level of 0.05 for the exploratory class and control class, so it very well may be expressed that the information regularly conveyed as displayed in table 4.

Table 4. Normality Test Results of Learning Outcomes

Class	Data	X^2count	X^2table	A	Decription
Experiment	Pretest	7,57	11,07	0,05	Normal
	Posttest	8,23	11,07	0,05	Normal
Control	Pretest	8,54	11,07	0,05	Normal
	Posttest	7,92	11,07	0,05	Normal

Based on the test criteria, namely that the sample comes from a normally distributed population if the Chi Square x^2count < x^2table and rejects the test criteria if the conditions are not met. Based on the table above, it was found that the pretest data for the experimental class x^2count < x^2table (7.57 < 11.07) and the control class 11.07) furthermore, control class x^2count < x^2table (7.92 < 11.07). So it very well may be reasoned that the pretest and posttest data in the two classes are normally distributed at a significant level of $\alpha = 0.05$.

b. Normality Test of Student Learning Activities

Normality test results for student learning activity data in both classes, namely experimental and control using the Chi Square test at the real level $\alpha = 0.05$ with the Chi Square criteria x^2count < x^2table, it is stated that the data is normally distributed which can be seen in table 5 below:

Table 5. Normality Test of Student Learning Activities

Class	x^2_{count}	x^2_{table}	A	Description
Experiment	6,71	11,07	0,05	normal distribution
Control	8,88	11,07	0,05	normal distribution

Based on the testing criteria, namely accepting samples originating from a normally distributed population if the Chi Square x^2count < x^2table and rejecting the testing criteria if the conditions are not met. Based on the table above, it was found student learning activity data in the experimental class x^2count < x^2table (6.71 < 11.07) and the control class, x^2count. As a result, a significant level of = 0.05 indicates that the

student learning activity data in the two classes is normally distributed.

c. Homogeneity Test of Learning Outcome Data

The homogeneity test was carried out to test the data variance in the two sample groups whether it was homogeneous or not. Testing the homogeneity of the data variance of the two sample groups was carried out using the F test with the formula :

$$F = \frac{Largest\ Variance}{smallest\ variance}$$

With the condition that F count < F table then the data is homogeneous. Based on the calculation results, the data obtained in table 6 below:

Table 6. Homogeneity Test of Learning Outcome Data

Class	Data	S2	Fcount	Ftable	Description
Experiment	Pretest	50,53	1,092	1,757	Homogene
	Posttest	25	1,437	1,757	Homogene
Control	Pretest	46,25	1,092	1,757	Homogene
	Posttest	35,93	1,437	1,757	Homogene

Based on Table 6 It appears that the pretest and posttest data for both classes are homogeneous because $F_{count} < F_{table}$.

d. Test the Homogeneity of Student Learning Activity Data

The homogeneity test was completed on whether student learning activity data in the two sample groups were homogeneous or not. Testing the homogeneity of data variance between two sample groups was using the F test with the formula:

$$F = \frac{Largest\ Variance}{smallest\ variance}$$

With the condition that F count < F table then the data is homogeneous. Based on the calculation results, the data obtained is presented in table 7 below:

Table 7. Test the Homogeneity of Student Learning Activity Data

Class	S^2	F_{count}	F_{table}	Description
Experiment	37,96	1,242	1,757	Homogene Data
Control	47,16			Homogene Data

Based on table 7, the F_{count} value is 0.804 and the F_{table} value with a significance level of $\alpha = 0.05$ is 1.757. By looking at this data it can be concluded that $F_{count} < F_{table}$ (1.242 < 1.757), indicating that the student learning outcomes data are homogeneous. If the data obtained is normally distributed and homogeneous then the hypothesis test can be continued, namely the one-sided t-test (right side).

e. Hypothesis Test 1

After the prerequisite tests had been completed, the right-sided t-test was used to test this hypothesis. Speculation testing is finished with a right-sided t-test to decide the acknowledgment or dismissal of the theory. The test measures in the event that $t_{count} > t_{table}$, the elective speculation (Ha) is acknowledged. Hypothesis I testing is done by calculating the t_{count} using the formula:

$$tcount = \frac{(\bar{x}1 - \bar{x}2) - do}{\sqrt{\frac{S1^2}{n1} + \frac{S2^2}{n2}}}$$

The elective speculation (Ha) to be tried is that the learning results of understudies instructed with the assistance of e-modules are higher than those of powerpoint media on electrolyte and non-electrolyte arrangement materials.Hypothesis test calculations can be found in the appendix and have been summarized in table 8.

Table 8. Test hypothesis 1 student learning outcomes

Class	$\bar{x}$	S^2	T_{count}	T_{table}	α	Description
Experiment	85,83	25	9,714	1,66	0,05	Ho is rejected and Ha is accepted
Control	73,19	41,41				

From the calculation table above, it is known that $t_{count} = 9.714$ and $t_{table} = 1.66$ where $t_{count} > t_{table}$. So that Ha is accepted and Ho is rejected. So it can be concluded that the learning outcomes of students taught with the help of e-module media are higher than the value with the help of powerpoint media.

f. Test Hypothesis 2

After the prerequisite tests had been completed, the right-sided t-test was used to test this hypothesis. Speculation testing is finished with a right-sided t-test to decide the acknowledgment or dismissal of the theory. The test measures on the off chance that $t_{count} > tt_{able}$, the elective speculation (Ha) is acknowledged. Hypothesis II testing is done by calculating the t_{count} using the formula:

$$tcount = \frac{(\bar{x}1 - \bar{x}2) - do}{\sqrt{\frac{S1^2}{n1} + \frac{S2^2}{n2}}}$$

The alternative hypothesis (Ha) to be tested is the learning activity of students taught with the help of e-modules is higher than that of powerpoint media on electrolyte and non-electrolyte solution materials. Hypothesis test calculations can be found in the appendix and have been summarized in table 9.

Table 9. Hypothesis Test II Student Learning Activities

Class	$\bar{x}$	S^2	Tcount	ttable	α	Description
Experiment	81,41	38,21	6,069	1,66	0,05	Ho is rejected and Ha is accepted
Control	72,08	49,14				

From the computation table above, it is known that $t_{count}t = 6.069$ and $t_{table} = 1.66$ where $t_{count} > t_{table}$. So that Ha is acknowledged and Ho is dismissed. So it very well may be presumed that the learning exercises of understudies instructed with the assistance of e-module media are higher than the value with the help of powerpoint media.

g. Hypothesis Test 3

Correlation analysis is used to measure how closely the connection among action and understudy learning results using a simple correlation test (rxy) using the Product Moment formula. This test is led to decide if the speculation in this review is acknowledged or dismissed. The test measures in the event that r-hit> r-table, reject (Ho), so (Ha) is acknowledged which implies that the tested coefficient is significant.

Table 10. Correlation test between Activity and Student Learning Outcomes

class	Data kelas	rcount	rtable	Description
Experiment	ΣX = 2931 ΣX^2= 239961 ΣY = 3090 ΣY^2 = 266100 ΣXY = 252580 N = 36	0,929734	0,329	Ha accepted, Ho rejected

Thus, the r_{count} in the trial class is 0.929 with an exceptionally high class, while the r_{table} at $\alpha = 0.05$ (N = 36) is 0.329. Since $r_{count} > rt_{able}$ then Ho is dismissed which implies Ha is acknowledged. This truly intends that there is a critical connection among's action and understudy learning results showed by the Venture Based Learning model helped by e-modules on the material of electrolyte and non-electrolyte arrangements.

CONCLUSION

Subsequent to leading examination, information investigation and speculation testing, the specialist got the accompanying ends : 1) The learning results of understudies showed utilizing the Undertaking Based Getting the hang of learning model helped by e-modules are higher than the learning results of understudies showed utilizing the Task Based Picking up learning model helped by ppt. 2) Understudy learning exercises showed utilizing the Venture Based Getting the hang of learning model helped by e-modules are higher than understudy learning exercises showed utilizing the Undertaking Based Picking up learning model helped by ppt. 3).The connection among exercises and understudy learning results with the impact of the Undertaking Based Picking up learning model helped by e-modules was gotten at 0.929 which has a high relationship meaning.

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