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Differences in Learning Outcomes and Student Activities Taught Using Project Based Learning and Discovery Learning Models on Electrolyte and Non-Electrolyte Solution Materials

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Absract : Differences in Learning Outcomes and Student Activities Taught Using Project Based Learning and Discovery Learning Models on Electrolyte and Non-Electrolyte Solution Materials. The purpose of this study is to ascertain if project-based and discovery learning students have different learning objectives and activities. It will be done so by employing rigorous quantitative research methodologies. Students from experimental classes X IPA 1 and X IPA 2 served as the research sample in this study. Student learning outcomes were measured using posttest scores, and student learning activity observation sheets were used to gauge student activity during the learning process. These data were used in this study. However, homogeneity and normalcy tests are prerequisites that must be completed before evaluating the hypothesis. The research results showed that the learning objectives and learning activities of experimental class 1 and 2 students who were taught using the PjBL and DL models were different, respectively. This is shown by the students in experimental class 1 having a greater average learning outcome value than students in experimental class 2. Similarly, students in experimental class 1 engage in more learning activities than those in experimental class 2. The hypothesis test findings indicate that there are differences between the learning activities of experimental classes 1 and 2, as determined by the t-test, where the significance value is less than 0.00 < 0.05.

Keywords : Learning outcomes, student learning activities, Problem Based Learning, Discovery Learning.

***Abstrak: Perbedaan Hasil Belajar dan Aktivitas Siswa yang Dibelajarkan Dengan Model Project Based Learning dan Discovery Learning Pada Materi Larutan Elektrolit Dan Non Elektrolit**. Tujuan penelitian ini yakni untuk memastikan apakah siswa pembelajaran berbasis proyek dan pembelajaran penemuan mempunyai tujuan dan kegiatan pembelajaran yang berbeda. Pendekatan penelitian kuantitatif yang tepat dapat diterapkan untuk hal ini. Penelitian ini mempekerjakan siswa X IPA 1 dan X IPA 2 dari kelas eksperimen sebagai sampel penelitian. Selama proses pembelajaran, tindakan siswa diukur melalui lembar observasi aktivitas belajar. Hasil posttest mencakup hasil belajar siswa. Namun, uji normalitas dan homogenitas diperlukan sebelum menilai hipotesis. Hasil penelitian menunjukkan bahwa tujuan pembelajaran dan aktivitas belajar siswa di kelas eksperimen 1 dan 2 berbeda, masing-masing diajar menggunakan model PjBL dan DL. Hal ini dibuktikan dengan nilai hasil belajar rata-rata siswa di kelas eksperimen 1 lebih tinggi dibandingkan siswa di kelas eksperimen 2. Selain itu, siswa di kelas eksperimen 1 melakukan aktivitas belajar lebih banyak daripada siswa di kelas eksperimen 2. Temuan uji hipotesis menunjukkan bahwa terdapat perbedaan aktivitas belajar kelas eksperimen 1 dan 2 yang ditentukan dengan uji t, dimana signifikansinya nilainya kurang dari 0,00 < 0,05.*

Kata kunci*: Hasil belajar, aktivitas belajar siswa, Problem Based Learning, Discovery Learning.*

▪ INTRODUCTION

Chemistry is a science that can be challenging to understand since some of its ideas are abstract. Electrolyte solutions are chemistry learning material that requires students to carry out experiments in testing solutions to understand the concept of the material (Kristalia, 2021). According to Sahnam (2021), chemistry learning is currently generally running, but it really needs to be improved further because based on the fact that chemistry scores are still less than optimal. In general, chemistry learning currently still tends to focus on teachers, so we need to change it little by little to student-focused learning. Therefore, the effectiveness of the transfer of chemical science and knowledge in schools needs to be increased so that the quality of learning is always maintained and the expected results can meet the set learning objectives (Sulistyowati, 2020).

There are four classes in Class XI Science at the Exemplary Private High School, according to the findings of interviews that researchers at the school in Medan conducted. Lecture and discussion techniques are frequent instructional strategies used by educators. The average student score is below 75 Minimum Completion Criteria (KKM) in both electrolyte and non-electrolyte solution material. This school, therefore, requires a learning strategy or model due to issues with the non-electrolyte and electrolyte solution content. Learning activities and participant learning outcomes can be impacted by developing an engaging and creative learning concept and training teachers to be effective facilitators to mould students into critical thinkers, highly analytical thinkers, and proficient communicators and collaborators in the learning process. Project-Based Learning and Discovery Learning are examples of applicable learning methods.

According to earlier studies, students frequently struggle to understand the distinctions between non-electrolyte and robust, weak electrolyte solutions, as well as how to assess each type of solution's qualities based on electrical conductivity (Kartini et al., 2018). Help with ionization, covalent molecules, polar compounds, and ionic compounds is sometimes required by students. According to Medina (2015), class X high school students understand the concept of electrolyte and non-electrolyte solutions. Students need to be actively involved in the learning process and supported by learning models to overcome these learning obstacles. The 2013 curriculum includes various teaching strategies, such as explorative models and problem-based learning (PjBL). More purposeful learning may be systematically delivered by this strategy. In order for them to independently explore and draw conclusions from the lesson's theme, students will be encouraged to think and behave creatively.

Project-based learning and discovery learning are 21st-century learning methods, according to Barus (Indarta et al., 2022). Helping students realize their full potential and acquire a range of abilities, including as problem-solving, creativity, knowledge reconstruction, and thinking, is the aim of the 21st-century learning paradigm. This 21st-century learning approach is crucial to the autonomous curriculum's implementation. The establishment of an autonomous curriculum centers on the acquisition of information that is the responsibility of the students themselves. Pupils get instruction in topics exploration, competency building, and independent thought. Instructors have a part to play in enabling the learning process as program designers and developers (Sanjaya & Desyandri, 2023).

Planning, producing (implementation), and processing are frequently included in project-based learning (Rahman et al., 2019). Students can improve their group study strategies using project-based learning, and the projects they do can give them practical experience. For instructors to serve as facilitators rather than learning resources, they should emphasize student-centred learning activities (Rezeki et al., 2015). According to Putri et al. (2017), discovery learning, on the other hand, is a model for creating a method of instruction where students actively explore and find themselves to produce outcomes that will stick in their memories and be difficult for them to forget. The design of problems, stimulation, collecting and analyzing data, verification, and generalization are among the tasks that make up the Discovery Learning paradigm (Halim, 2019).

▪ METHOD

Class X Science 1 for experiment I and class X Science 2 for experiment II comprised the study's sample. This study uses quantitative research approaches. The study used student activities and learning outcomes as its data collection methods.

This research used a pretest-posttest control group design. Arikunto (2019), stated that in the pretest-posttest control group design, two sample groups were used randomly from the population.

Tabel 1. Research Design

Class	Pretest	Handling	Posttest
Experiment I	T1	X	T2
Experiment II	T3	Y	T4

Information:

X = The method of instruction used with experimental class I was Project Based Learning (PjBL).

Y = The experimental class II received treatment, specifically using the Discovery Learning (DL) methodology.

T1 = The initial value of the experimental class group I under project-based learning (PjBL) study.

T2 = Final results for the first experimental class, which received instruction using the Project Based Learning (PjBL) paradigm

T3 = Starting value of group II of the experimental class, which received instruction using the Discovery Learning (DL) paradigm

T4 = The experimental class group II's final score, which was determined by applying the Discovery Learning (DL) paradigm.

Pre-test and post-tests on materials containing electrolyte and non-electrolyte solutions were used to collect data on learning outcomes. The SPSS 25 program was used to examine the data, and a two-party t test was used specifically. In the meantime, student activity is recorded by scoring on a questionnaire for each indicator monitored at each meeting based on direct observation of student engagement during the learning process. Data homogeneity tests, data normalcy tests, and hypothesis testing were used in this study's data analysis (Akbar, 2019).

The research flow is shown in the following figure.

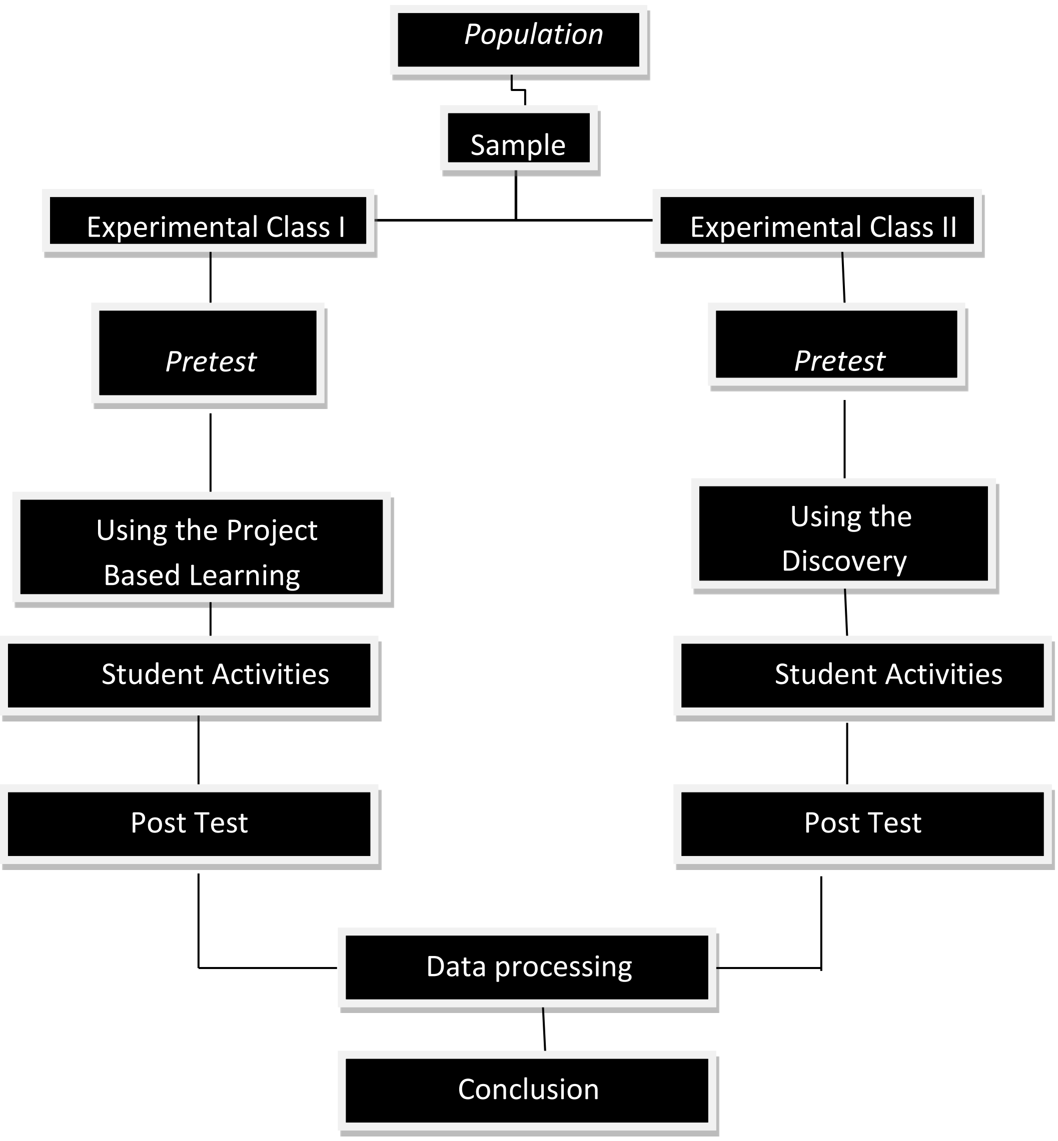

Figure 1. Research Flow

- **RESULT AND DISCUSSION**

1. Analysis of Learning Results Data

The learning outcomes data for both Experimental Classes 1 and 2 were gathered and are displayed in the graphic below:

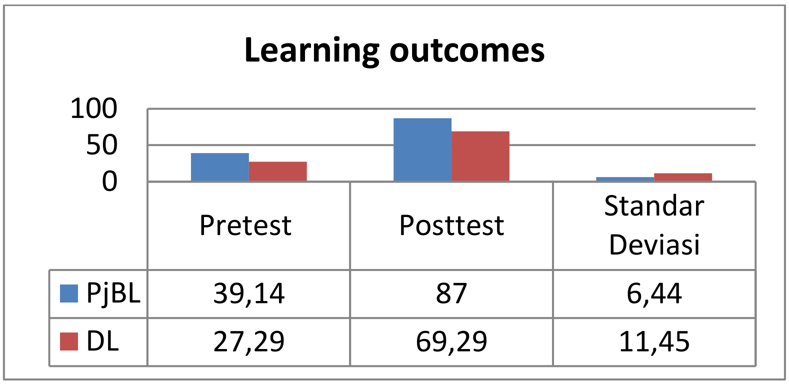

Figure 2. Student learning outcomes with the PjBL & DL model

The learning objectives of students taught electrolyte and non-electrolyte solution materials utilizing project-based learning and discovery learning methodologies are depicted in the accompanying graphic. The accompanying illustration shows the students' learning results in experimental classes 1 and 2.

a. Normality Test

The researcher conducted a data precondition test, known as the normality test, to ascertain whether or not the data was generally distributed before evaluating the hypothesis. With the rigorous Shapiro-Wilk test, the data were analyzed at a significance level of 5% using SPSS version 25.0. The following techniques can be applied to ascertain normalcy according to the findings of the normality test..

Table 2. Data Normality Test Results for Experimental Class 1

Data	*Shapiro-Wilk* Sig	Sig level	Details
Pretest	0,062	0,05	Normally Distributed Data
Posttest	0,066	0,05	Normally Distributed Data

Experimental class 1 has pretest significance level of 0.062 and posttest significance level of 0.066, both more than 0.05 (sig value > α(0.05)), as the above table shows. It is therefore feasible to assert that the distributions data are regular. Results of the experimental class 1 normality test, including pre- and post-test.

Table 3. Data Normality Test Results for Experimental Class 2

Data	*Shapiro-Wilk* Sig	Sig level	Details
Pretest	0,063	0,05	Normally Distributed Data
Posttest	0,165	0,05	Normally Distributed Data

In experimental class 2, the pretest significance level is 0.063 and the posttest significance level is 0.165, both of which have values greater than 0.05 (sig value > α(0.05)), as can be seen from the next table. As a result, it is possible to claim that the pre- and post-test data distributions are regular. Results of the experimental class 2's pretest and posttest data for the normalcy test.

b. Homogeneity Test

In this study, the homogeneity test was carried out at a significance level of 5% or 0.05 using the SPSS program and the Levene test. If the sig value is higher than α (0.05), the data are homogeneous (Khoirunnisa, 2019). Based on the findings of the homogeneity test, the following homogeneity was established.

Table 4. Data Homogeneity Results for Experiment 1 class

Data	*Levene* Sig	Sig Level	Details
Pretest	0,291	0,05	Homogeneous
Posttest		0,05	Homogeneous

Students using the Project Based Learning (PjBL) paradigm had homogeneous test significant values of 0.291, as seen in the mentioned table. The results show that there is homogeneity in the pretest and posttest data, with a significance value greater than α (0.05).

The following table contains information on the experimental class 2 students' pretest and posttest homogeneity test results.

Table 5. Experimental Class 2 Homogeneity Test Results

Data	*Levene* Sig	Sig Level	Details
Pretest	0,085	0,05	Homogeneous
Posttest		0,05	Homogeneous

The aforementioned data illustrates that pupils using the Discovery Learning (DL) paradigm had homogeneous test significance values of 0.085. The results show that there is homogeneity in the pretest and posttest data, with a significance value greater than α (0.05). Information from the experimental class 2 students' pretest and posttest homogeneity test.

c. Differences in Student Learning Outcomes (Hypothesis Test 1)

The Independent Sample T-test was employed at a significance level of 5% to see whether there were any differences in the learning outcomes of students taught using the Project Based Learning and Discovery Learning models using the SPSS 25.0 software. If the sig value exceeds 0.05, Ha is rejected, and H0 is approved. In the interim, if the sig value is less than 0.05, Ha is allowed, and H0 is rejected (Halalutu, 2019). The results of the Independent Sample T-test are shown in the following table.

Table 6. Hypothesis Test Results Posttest Data

Data	*t – test sig*	Sig Level	Details
Posttest	0,00	0,05	Ha accepted, Ho rejected

The Independent Sample T-test has a significance value of 0.00, as the table demonstrates. These data show a lower significance value of 0.00 <0.05. Since it can be shown that there are differences in the student learning outcomes taught by using the Project Learning and Discovery Learning models in electrolyte and non-electrolyte solution materials, Ha is accepted, and Ho is rejected.

According to Jayadiningrat et al. (2019), the discovery learning model can lead to a remarkable increase in student learning activities by 84% and outcomes by 88% when used with electrolyte and non-electrolyte solution materials. Furthermore, a study (Herita, 2022) suggests that the Discovery Learning paradigm, when applied to electrolyte and non-electrolyte solution materials, can result in a substantial increase in student learning outcomes to 82% and student learning activities to 83%. (Bere et al., 2022) show in their research that the application of the Discovery Learning paradigm to electrolyte and non-electrolyte material solutions can significantly improve student learning outcomes.

d. Influencing Factors

According to Sasmono's (2018) research, it was possible to raise student learning outcomes from 55% to 97% by implementing the project-based learning paradigm in chemistry-related instructional materials. Researchers have found that when students apply the project-based learning model in groups, they learn in greater ways and achieve better learning outcomes. By discussing ideas with their group members, students may find it simpler to grasp concepts through group learning. In addition, students are required to collaborate with their friends on projects. The fact that pupils already have a solid knowledge of the nature of chemistry means that this will greatly improve student learning results.

In this study, the project-based learning strategy yielded better learning results than the discovery learning paradigm. One factor that has a big impact on reaching learning objectives is the learning environment. Unfavorable learning settings can cause students to lose interest in what they are studying and to have a poor understanding of the subject matter. Furthermore, kids who get instruction through the discovery learning paradigm are not yet used to this kind of inquiry-based learning. As students still frequently struggle to discover their own knowledge, errors about real concepts and concepts learned by students are not unusual.

2. Student Learning Activities

The average activity value results for experimental classes 1 and 2 are displayed in the graphic below. Experimental classes 1 and 2 were taught by PjBL and DL, respectively.

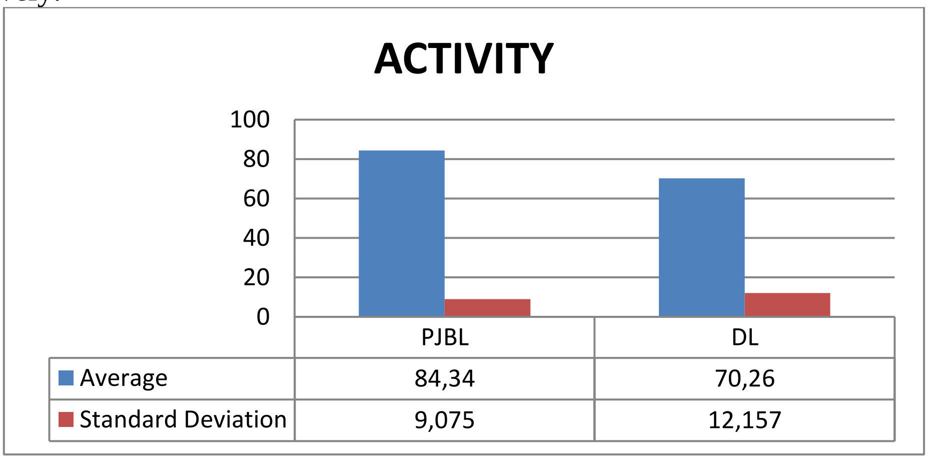

Figure 3. Diagram of Average Values for Experimental Class 1 and 2 Students' Learning Activities

Students in experimental classes 1 and 2, which use project-based and discovery learning methods, display a range of activity ratings, as seen in the figure below. This contrast highlights the study's findings, which demonstrate that the project-based learning model works better than the discovery learning strategy in terms of encouraging student involvement.

a. Non-Test Normality

Using the SPSS version 25.0 software and the Shapiro-Wilk test at a significance level of 5%, the normality test is performed to ascertain if the data obtained is usually distributed. The normality test results can be used to determine normalcy using the following methods.

Table 7. Normality Test of Student Learning Activity Data

Data	*Shapiro-Wilk* Sig	Sig Level	**Details**
PjBL	0,092	0,05	Normally Distributed Data
DL	0,069	0,05	Normally Distributed Data

Activity significance levels in experimental classes 1 and 2 are 0.092 and 0.069, respectively, according to the above table. This indicates that the activity values in both experiments are larger than 0.05 (sig value > α (0.05)). hence it can be said that the information gathered from the experimental class 1 and experiment 2 activities is regularly dispersed.

b. Hypothesis Testing Student Learning Activities

This study employed the Independent Sample T-test with the SPSS 25.0 software at a significance threshold of 5% to determine whether there were any differences between the student learning activities taught using the Project-Based Learning and Discovery Learning models. The results of the Independent Sample T-test are shown in the following table.

Table 8 Hypothesis Test Results for Student Learning Activity Data

Data	***t – test Sig***	**Sig Level**	**Details**
Learning activity	0,00	0,05	Ha accepted, Ho rejected

The significance value, as seen in the above table, is 0.00<0.05. Consequently, there are variations in the learning assignments provided to students in electrolyte and non-electrolyte solutions when using the Project Based Learning and Discovery Learning models. As a result, Ha was accepted while H0 was rejected.

Research was conducted on the Project Based Learning (PjBL) paradigm by Sitaresmi et al. (2017). Based on the findings, learning activities 46 (75.76% completeness) using materials comprising electrolyte and non-electrolyte solutions might benefit from using the PjBL model. This may result in a 73.53% increase in student learning achievement. Samono (2018) claims that students' learning results in electrolyte and non-electrolyte solutions may be enhanced by 97% when employing the Project Based Learning technique. This is predicated on an 82-point average. Furthermore, research indicates that using Project Model Based Learning (PjBL) may enhance learning completion rates by 80.56% and boost student involvement, hence improving students' comprehension of electrolyte and non-electrolyte solution content (Wahyuni, 2020).

c. Factors that Influence Activities

According to the research findings, the project-based learning approach's average value for the student learning activities was 80.83. In the meantime, the discovery learning paradigm's average value for the student activities taught was 70.46. This suggests that project-based learning activities are superior to discovery learning activities when it comes to student engagement. Students still struggle and need help to adjust to discovery-based learning activities, even after being taught using the discovery learning paradigm. Students typically take a passive approach to learning as a result. Students become sluggish and unconfident while expressing their knowledge and queries about the reaction rate content as a result of this inadequate comprehension. According to this project-based learning approach is more successful in raising student engagement, according to this research (Aprilianingrum & Wardani, 2021).

▪ CONCLUSION

Following investigation, the following findings can be drawn: Different student activities are taught using the Project Based Learning and Discovery Learning models in electrolyte and non-electrolyte solution materials, and there are variations in the learning results for students taught using these methods of teaching.

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