Implementation of The Discovery Learning Model to Improve The Activity and Learning Outcomes

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Abstract: This study used classroom action Research to improve student learning activities and outcomes on buffer solutions for Grade XI 1 at SMAN 6 Pekanbaru through discovery learning. The model was applied through stages of stimulation, problem statement, data collection, data processing, verification, and generalization. CAR cycles of planning, action, observation, and reflection addressed learning problems arising from the abstract and microscopic nature of buffer concepts. Participants were 36 students of class XI 1. Results show student learning activities increased from 57.61% (Cycle I, adequate) to 71.10% (Cycle II, good), meeting the success criterion. Student learning outcomes similarly improved, with classical mastery rising from 63.88% in Cycle I to 94.44% in Cycle II, and mean scores increasing accordingly. Findings indicate that systematically implemented discovery learning, supported by teacher scaffolding and iterative refinement, effectively enhances both engagement and achievement in buffer solution topics. The study recommends broader application and further Research on scaffolded discovery approaches across classes.

Abstrak: Penelitian ini adalah penelitian tindakan kelas yang bertujuan meningkatkan aktivitas dan hasil belajar peserta didik pada materi larutan penyangga kelas XI–1 SMAN 6 Pekanbaru melalui penerapan model *discovery learning*. Model tersebut dilaksanakan melalui tahap stimulasi, identifikasi masalah, pengumpulan data, pengolahan data, verifikasi, dan generalisasi. PTK dilakukan dengan siklus perencanaan, pelaksanaan, pengamatan, dan refleksi. Subjek penelitian terdiri dari 36 siswa kelas XI–1. Hasil observasi menunjukkan rata-rata aktivitas siswa pada Siklus I sebesar 57,61% (kategori cukup) dan meningkat menjadi 71,10% pada Siklus II (kategori baik), sehingga memenuhi kriteria keberhasilan. Hasil belajar juga meningkat, dengan persentase ketuntasan klasikal 63,88% pada Siklus I menjadi 94,44% pada Siklus II, disertai kenaikan nilai rata-rata dari 80,28 menjadi 88,52. Temuan ini mengindikasikan bahwa penerapan discovery learning secara siklik dan berorientasi pada scaffolding guru efektif meningkatkan keterlibatan siswa dan pencapaian belajar pada materi larutan penyangga. Rekomendasi penelitian ini adalah pengembangan pelatihan bagi guru dan penelitian lanjutan pada kelas dan materi yang berbeda lokal.

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A. Introduction

The quality of learning can be improved by applying learning models aligned with students' needs and characteristics in the classroom. Selecting appropriate learning models is essential because effective models can encourage active student participation and positively Influence learning outcomes. Learning activities are designed to create meaningful learning experiences that enable students to develop their potential and various abilities, including critical thinking, creativity, knowledge construction, and problem-solving skills (Abidin & Iskandar, 2022). Therefore, improving the quality of learning requires instructional approaches that actively engage students rather than positioning them as passive recipients of information.

Learning is considered effective when students are actively involved in the learning process. However, in many classroom practices, students tend to show low participation and experience difficulties in responding to teachers' questions, which ultimately results in unsatisfactory learning outcomes. This condition is often associated with students' low interest and motivation to learn, indicating the need for an instructional model that actively involves students in constructing knowledge. One learning model that addresses this need is discovery learning, which encourages students to explore, investigate, and discover concepts independently rather than relying solely on teacher-directed instruction.

Discovery learning is a learning method that emphasizes student activity and mental processes in acquiring new knowledge through exploration and inquiry. According to Nugraha (2022), discovery learning highlights students' active engagement in a series of mental activities that support the formation of conceptual understanding. This model emphasizes students' direct involvement in the learning process, enabling them to build knowledge from their own learning experiences. In chemistry learning, discovery learning is particularly relevant for topics that require deep conceptual understanding, such as buffer solutions, which students often find difficult due to their abstract nature and reliance on microscopic concepts (Indriyani et al., 2023).

Buffer solutions involve chemical concepts that can be directly observed through experimental activities, such as the ability of a solution to maintain its pH when acids or bases are added. Through discovery learning, students are given opportunities to observe these phenomena firsthand and independently uncover the underlying principles. The buffer solution topic encompasses several key concepts, including the components of buffer solutions (acidic and basic buffers), their working principles, preparation methods (direct and indirect), pH calculations, and their roles in everyday life and industry. These characteristics make buffer solutions a suitable context for implementing discovery-based learning to promote deeper and more meaningful conceptual understanding.

Empirical observations conducted in class XI 1 at SMAN 6 Pekanbaru during the 2024/2025 academic year revealed several learning problems in chemistry lessons, particularly on acid–base material. More than 60% of students did not respond to teachers' questions, showed low enthusiasm during lessons, and rarely expressed ideas or asked questions related to the material. Furthermore, the results of daily assessments indicated

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that only 42% of the 36 students achieved the minimum mastery criterion (KKTP) of 75, while 58% failed to meet the required standard. Students perceived the material as difficult due to its conceptual complexity and calculation-based nature, which further hindered their engagement in the learning process.

Although the discovery learning model had been formally implemented in the classroom, its application was not optimal. During the stimulation stage, teachers did not provide sufficient support through discourse, images, or videos, leading students to struggle to understand the initial concepts. During the problem identification stage, students' thinking skills were not adequately stimulated, resulting in limited engagement. Data collection relied primarily on textbooks, and teacher guidance during data processing was minimal, leading to students' difficulties in solving problems. Time constraints also affected the verification and generalization stages, leading to rushed presentations and often omitted joint conclusions. These shortcomings contributed to low student activity and learning outcomes, indicating the need for systematic instructional improvement through classroom action Research.

Classroom action Research serves as a reflective and corrective approach aimed at improving teaching practices and learning outcomes through planned actions, observations, and reflections. By applying classroom action Research, teachers can identify learning problems, test instructional strategies, and evaluate their impact on student performance. Previous studies have demonstrated that classroom action Research combined with the discovery learning model can effectively enhance student activity and learning outcomes. Apsari (2022) reported significant improvements in students' engagement and achievement in chemistry learning on redox reactions through discovery-learning-based classroom action Research. Similarly, Yuliana et al (2018) emphasized that discovery learning fosters students' curiosity, intrinsic motivation, and sense of responsibility for their own learning. Erlidawati & Habibati (2020) also found notable increases in student activity and learning outcomes in thermochemistry lessons using the discovery learning model.

However, despite extensive Research on discovery learning in chemistry education, most studies tend to focus on general chemistry topics or emphasize learning outcomes without providing a balanced, detailed analysis of student learning activities, particularly in the context of buffer solutions. In addition, limited attention has been given to classroom action Research that addresses refining the implementation of discovery learning when the model has already been applied but not optimally executed in real classroom settings. This condition indicates a Research gap in the need for systematic instructional refinement to enhance both student learning activities and learning outcomes in abstract chemistry.

Based on this gap, this study explicitly addresses the following Research questions: how does the implementation of the discovery learning model through classroom action Research improve student learning activities, and to what extent does it enhance student learning outcomes on buffer solution material in class XI 1 of SMAN 6 Pekanbaru? Therefore, this study offers novelty by implementing classroom action Research to optimize the application of the discovery learning model specifically for buffer solution material in

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senior high school chemistry. Unlike previous studies that focus primarily on learning outcomes, this Research simultaneously examines improvements in student learning activities and learning outcomes across learning cycles while addressing practical implementation issues encountered by teachers. Accordingly, this study aims to improve student learning activities and outcomes by applying the discovery learning model in class XI 1 at SMAN 6 Pekanbaru on buffer solution material.

B. Method

This study employed a Classroom Action Research (CAR) approach to improve student learning activities and outcomes through systematic instructional improvement. Classroom action Research is a form of reflective and corrective action conducted collaboratively to address real classroom problems and enhance the quality of the learning process through iterative cycles of planning, action, observation, and reflection. The CAR model used in this study was based on Kurt Lewin's action Research framework, which is widely recognized as a foundational model in classroom action Research due to its clear and cyclical structure consisting of four main stages: planning, action, observation, and reflection (Arikunto et al., 2015). This design was selected because it enables teachers and researchers to continuously evaluate instructional practices and implement improvements grounded in classroom realities.

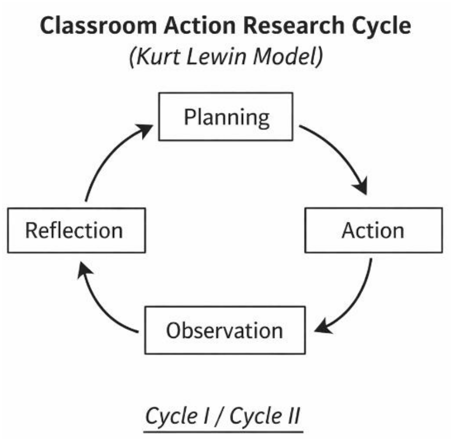

Figure 1. Classroom Action Research

The Research was conducted at SMAN 6 Pekanbaru during the even semester of the 2024/2025 academic year. The participants in this study were 36 students from class XI 1, comprising 27 females and 9 males. This class was selected as the Research subject because preliminary observations and interviews revealed low student participation during chemistry lessons, particularly in acid–base material, and learning outcomes that had not yet met the predetermined minimum mastery criterion (KKTP) of 75. These conditions indicated the need for instructional improvement through a structured classroom action Research approach.

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The classroom action Research was implemented in two cycles, with each cycle consisting of two meetings. Each cycle followed the four stages of the Kurt Lewin model. In Cycle I, the planning stage involved preparing discovery learning-based teaching modules, student worksheets (LKPD), learning outcome tests, and observation sheets for both student and teacher activities. The action stage involved implementing the discovery learning model in teaching buffer solution material. During this stage, students were engaged in learning activities aligned with the syntax of discovery learning, including stimulation, problem identification, data collection, data processing, verification, and generalization. Observations were conducted simultaneously to record student learning activities and teacher performance using the prepared observation sheets. The reflection stage revealed several limitations, such as insufficient learning stimuli, limited student confidence in identifying problems, minimal use of diverse learning resources, and ineffective time management during presentations and conclusion activities.

Based on the Cycle I reflection results, improvements were implemented in Cycle II. The planning stage in Cycle II focused on revising learning stimuli by incorporating discourse, images, and videos, strengthening teacher guidance during group discussions, and improving time allocation for verification and generalization stages. The action stage involved re-implementing the discovery learning model with these refinements, emphasizing active student participation and collaborative learning. Observations indicated that students became more engaged, actively asked questions, and participated more confidently in group discussions. The reflection stage in Cycle II confirmed that the improvements led to a more conducive learning environment and enhanced student involvement in the learning process.

The instruments used in this study consisted of student learning activity observation sheets and learning outcomes tests. The observation sheets were designed to assess student participation across the stages of discovery learning, including orientation, stimulation, problem identification, data collection, data processing, verification, generalization, and evaluation. Learning outcomes were measured using a multiple-choice test comprising 15 items, developed based on buffer solution learning indicators and covering cognitive levels from C1 to C4. These instruments were used consistently across both cycles to ensure data comparability.

Data analysis was conducted using descriptive percentage analysis. Student learning activities were analyzed by calculating the percentage of observed activities during the learning process. Learning outcomes were analyzed both individually and collectively to determine the proportion of students who achieved the minimum mastery criterion (KKTP). Individual mastery was calculated by comparing each student's score with the KKTP, while classical mastery was determined based on the percentage of students who met or exceeded the criterion. This approach aligns with previous studies that employed percentage-based analysis to evaluate learning activities and outcomes in classroom action Research (Pahdianti et al., 2023).

The success criteria for this study were determined prior to implementing the action. The Research was considered successful if at least 75% of students achieved the minimum mastery criterion (KKTP = 75) for learning outcomes. In addition, student learning activity was considered successful if it reached a minimum percentage of 61%, categorized as good. If these criteria were achieved in Cycle II, the classroom action Research was deemed successful in meeting its objectives.

C. Result

This section presents the results of the classroom action Research conducted to examine the effectiveness of the discovery learning model in improving student learning activities and learning outcomes. The results are organized into two main aspects aligned with the Research questions: student learning activities and student learning outcomes, which were observed and measured across two learning cycles.

Student Learning Activities

Student learning activities were observed during the implementation of the discovery learning model in Cycle I and Cycle II using an observation sheet developed based on the stages of discovery learning. The observation focused on students' engagement during orientation, stimulation, problem identification, data collection, data processing, verification, generalization, and evaluation stages.

Table 1. Student Learning Activities in Cycle I

No	Activity	Average Activity Cycle I
1.	Students pay attention to and respond to orientation, apperception, motivation, and learning objectives.	65,62
2.	Students pay attention to and respond to stimuli provided by the teacher	58,68
3.	Students can identify problems in the worksheet	64,71
4.	Collect data/information through group discussions.	57,29
5.	Process information and answer questions in the worksheet in groups.	54,86
6.	Present the discussion results.	58,33
7.	Conclude learning.	48,26
8.	Conduct evaluations	52,08
	Percentage (%)	**57,33**

Table 1 presents the percentage of student learning activities in Cycle I. The results show that the average percentage of student learning activities in cycle I was 57.33%, which falls into the sufficient category and had not yet met the predetermined success criteria. Several activity indicators, such as concluding learning and conducting evaluations, showed relatively low percentages, indicating that students were not yet fully engaged in the learning process during the initial implementation of the discovery learning model.

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Table 2. Student Learning Activities in Cycle II

No	Activity	Average Activity Cycle II
1.	Students pay attention to and respond to orientation, apperception, motivation, and learning objectives.	75,34
2.	Students pay attention to and respond to stimuli provided by the teacher	75,34
3.	Students can identify problems in the worksheet	67,70
4.	Collect data/information through group discussions.	70,13
5.	Process information and answer questions in the worksheet in groups.	73,96
6.	Present the discussion results.	72,22
7.	Conclude learning.	70,13
8.	Conduct evaluations	69,09
	Percentage (%)	**71,74**

Table 2 shows the percentage of student learning activities in Cycle II after instructional improvements were implemented, based on Cycle I reflection results. The findings indicate that the average percentage of student learning activities increased to 71.74%, which is categorized as good and meets the established success criteria. Improvements were observed across all activity indicators, including students' ability to identify problems, collect and process data through group discussions, present discussion results, and draw conclusions from the learning.

A comparison between Cycle I and Cycle II demonstrates a clear increase in student learning activities. The improvement from 57.33% in Cycle I to 71.74% in Cycle II indicates that implementing the discovery learning model through classroom action Research successfully enhanced student participation and engagement throughout the learning process.

Following the improvement in student learning activities across learning cycles, student learning outcomes were further analyzed to determine the extent to which the discovery learning model contributed to students' academic achievement.

Student Learning Outcomes

Student learning outcomes were measured using written tests administered at the end of each learning cycle. Figure 2 illustrates the percentage of student learning outcomes achieved in Cycle I and Cycle II.

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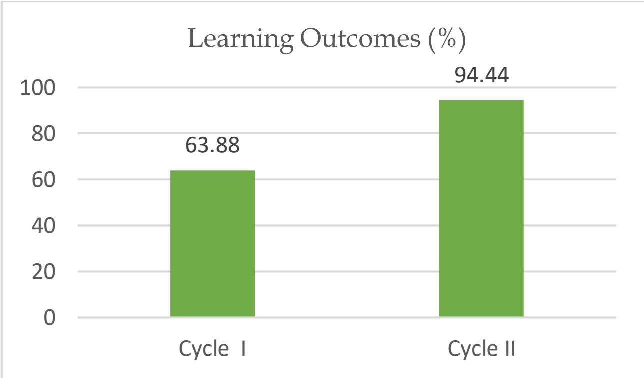

Figure 2. Percentage of student learning outcomes

The results show that the percentage of student learning outcomes in cycle I reached 63.88%, with an average score of 80.28, which had not yet met the predetermined success criteria. In Cycle II, the percentage of students meeting learning outcomes increased substantially to 94.44%, with an average score of 88.52, indicating that most students had met the minimum mastery criterion (KKTP = 75).

Table 3. Classical Completion of Each Indicator for Class XI Students at SMAN 6 Pekanbaru

Individual Evaluation Results				
	Meeting 1	Meeting 2	Meeting 3	Meeting 4
Complete	25	34	36	36
Incomplete	11	2	0	0
(%) KK	69,44	94,44	100	100

Further details on student mastery are presented in Table 3, which shows the classical completeness of student learning outcomes across meetings. The table indicates a progressive increase in classical mastery from the first meeting to the fourth meeting. While classical mastery in the first meeting had not yet reached the success criteria, the second meeting showed significant improvement, and complete mastery was achieved in the third and fourth meetings, with all students meeting the required standard.

Table 4. Comparison Between Cycles

Cycle 1		**Cycle 2**	
Activity	Learning Outcomes	Activity	Learning Outcomes
57,33	63,88	71,74	94,44
Incomplete		Complete	

Overall, the results demonstrate that implementing the discovery learning model through classroom action Research led to consistent improvements in student learning activities and learning outcomes. Student engagement increased from the sufficient category in Cycle I to the good category in Cycle II, while student learning outcomes improved from not meeting to exceeding the predetermined mastery criteria. These findings indicate that

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the instructional improvements implemented across learning cycles effectively supported the achievement of the Research objectives.

D. Discussion

Learning activities play a crucial role in effective teaching and learning by reflecting students' physical and mental engagement during the learning process. Active involvement allows students to construct knowledge, develop higher-order thinking skills, and meaningfully engage with learning tasks. The findings of this study demonstrate that implementing the discovery learning model through classroom action Research effectively improved student learning activities, thereby addressing the first Research question. The discovery learning model provides structured opportunities for students to explore concepts, formulate problems, and engage in inquiry-based learning aligned with their learning needs (Rismawati et al, 2022).

Improvements in student learning activities were observed across all stages of the discovery learning process. In the orientation, apperception, and motivation stages, increased student engagement indicates that contextualized learning activities and guiding questions enhanced students' readiness and interest in learning. This improvement suggests that meaningful learning begins when students are cognitively and emotionally prepared to engage with instructional content. Similarly, the stimulation stage showed substantial improvement when teachers provided learning stimuli in the form of problems, images, and learning situations that encouraged observation and exploration. Effective stimulation creates conditions that support learning interactions and promote active cognitive engagement, allowing students to construct understanding through analysis rather than memorization (Wicaksono, 2022; Sinambela, 2017).

Gradual improvements in the problem identification stage indicate that students became more capable of formulating questions and identifying core problems independently. Initially, students tended to rely on teacher examples, but with increased guidance and scaffolding, they demonstrated improved critical thinking skills and greater confidence in transforming information into investigable questions (Rosinta, 2020). This shift reflects students' growing internalization of scientific inquiry processes, which are essential components of discovery learning. Furthermore, increased engagement during data collection suggests that students developed a stronger sense of responsibility for their own learning. By actively seeking information from various sources, students assumed the role of active learners rather than passive recipients, consistent with the principles of inquiry-based learning (Khasinah, 2021).

The most notable improvement in student learning activity occurred during the data processing and verification stages, indicating enhanced analytical and interpretive skills. At these stages, students processed, classified, and evaluated information to support conclusions, reflecting increased higher-order thinking abilities (Khasinah, 2021). Improvements in generalization and evaluation further demonstrate that students became more capable of synthesizing information and reflecting on their learning processes.

https://doi.org/10.51276/edu.v7i1.1415

Collectively, these findings confirm that discovery learning, when implemented systematically through classroom action Research, can foster comprehensive student engagement across cognitive, affective, and procedural dimensions of learning.

In addition to improving learning activities, the study found that increased student engagement was accompanied by significant improvements in learning outcomes, thereby addressing the second Research question. The rise in learning outcomes from Cycle I to Cycle II indicates that active involvement in discovery-based learning contributed to deeper conceptual understanding and improved academic achievement. Observations during the learning process revealed that students were more focused, actively participated in discussions, and demonstrated greater confidence in expressing ideas. These behavioral changes created a more conducive learning environment, supporting academic success. This finding supports the view that active learning and student engagement are critical determinants of learning outcomes (Djarwo, 2020).

The discovery learning model encourages collaborative learning through group discussions, peer interaction, and verification of ideas. Such collaborative activities help students clarify misunderstandings, articulate reasoning, and construct shared understanding. Previous studies have similarly reported that discovery learning can improve student activity and learning outcomes across various subjects (Christijanti & Isnaeni, 2014; Istiana et al., 2015; Suprayanti et al., 2017; Putra et al., 2017; Sugiarti & Widhiyani, 2013). In this study, group discussions played a central role in enhancing learning outcomes, particularly during the verification stage, where students collectively examined the accuracy of their answers before presenting results, as also noted by Masdariyah & Nurhayati (2019).

The findings further highlight the importance of teacher scaffolding in optimizing the effectiveness of discovery learning. Although discovery learning emphasizes student independence, insufficient guidance can lead to confusion or cognitive overload. The improved learning outcomes observed in Cycle II suggest that effective scaffolding—such as guiding questions, structured tasks, and timely feedback—enabled students to overcome learning difficulties and translate learning activities into academic achievement. This aligns with previous findings that discovery learning, when supported by appropriate facilitation, significantly enhances both student activity and learning outcomes (Erlidawati & Habibati, 2020; Apsari, 2022).

Moreover, the study indicates that discovery learning can accommodate students with varying abilities when combined with differentiated scaffolding. Students with lower ability levels benefited from more direct guidance to support conceptual development, while higher-ability students progressed more quickly toward independent inquiry. This finding underscores the critical role of teachers as facilitators who adapt instructional support to meet diverse learning needs. Overall, the implementation of discovery learning through classroom action Research not only improved student learning activities and outcomes but also promoted inclusive and meaningful learning experiences that support students' cognitive and motivational development.

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E. Implication

The findings of this study imply that the application of the discovery learning model can effectively enhance student learning activities and learning outcomes when implemented systematically. The discovery learning model promotes a shift in instructional practices from teacher-centered to student-centered approaches, requiring students to actively explore, question, and construct knowledge. At the same time, teachers are required to adopt more adaptive roles as facilitators who guide, support, and scaffold student learning. These changes highlight the need for an educational environment that supports meaningful, inquiry-based, and exploratory learning processes. Although implementing discovery learning presents challenges, particularly in time management and classroom control, its potential to strengthen conceptual understanding and develop essential 21st-century skills remains substantial.

Furthermore, discovery learning encourages the development of critical thinking skills by engaging students in problem analysis rather than passive information reception. Through continuous exposure to inquiry and problem-solving tasks, students learn to evaluate evidence, formulate hypotheses, and draw logical conclusions. This model is also effective in fostering collaboration, as most learning activities are conducted through group work that requires students to communicate, negotiate, and share responsibilities. By assigning different roles or data sources to each group member, students are encouraged to integrate diverse perspectives and synthesize information collectively. In addition, discovery learning supports creativity by presenting open-ended problems that allow multiple solution pathways, motivating students to generate original ideas and develop investigative strategies. Collectively, these implications suggest that discovery learning is not only effective for improving academic performance but also for cultivating higher-order thinking, collaboration, and creativity that are essential for students' long-term learning and personal development.

F. Limitation and Suggestion for Further Research

Based on the Research conducted, the author recommends that the discovery learning model can be an alternative for classroom improvement by carefully allocating time so that each learning stage can proceed as planned. Although the Discovery Learning model is highly effective, its application in classes with large numbers of students or with highly varying ability levels has several limitations. In large classes, teachers struggle to provide individual guidance or intensive supervision to each group. As a result, students who require more support (for example, those with lower abilities or those who tend to be passive) may be neglected and miss out on the essence of the independent discovery process. Conversely, students with higher abilities may not be optimally challenged.

Furthermore, time management is a significant challenge. Suggestions for further Research include exploring the effectiveness of the Discovery Learning model on more complex materials that require abstract thinking, such as quantum physics or organic chemistry. This Research could examine the extent to which this model can be used to teach

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difficult-to-visualize concepts and identify the most effective scaffolding strategies to support learners.

G. Conclusion

Based on the results of the study, it can be concluded that the discovery learning model can improve the learning activities of class XI 1 students of SMAN 6 Pekanbaru, as evidenced by the percentage of student learning activities in cycle I of 57.16%, including the sufficient category, which has not yet reached the success criteria, and increased in cycle II, a value of 71.7% was obtained, including the good category, which has reached the success criteria, which is more than 61%. The increase in the value of each indicator of student activity from Cycle I to Cycle II: the highest value in Cycle I was in the Stimulation stage at 67.36, while in Cycle II the highest value was in the Orientation stage (apperception) at 75.345. Conversely, the lowest value in both cycles occurred in the Evaluation stage, at 48.6 in Cycle I and 69.09 in Cycle II. The discovery learning model can also improve students' learning outcomes in class XI 1 SMAN 6 Pekanbaru, as evidenced by the percentage of student learning outcomes in cycle I reaching 63.88% (with an average value of 80.28) and not yet meeting the success criteria. Meanwhile, the percentage of student learning outcomes in cycle II was 94.44% (with an average of 88.52), which met the success criteria for the set outcome value.

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