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EXPLORING THE EFFICACY OF DRILL AND PRACTICE METHODS IN IMPROVING STUDENT ENGAGEMENT AND LEARNING OUTCOMES ON THE SALT HYDROLYSIS TOPIC

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Abstract: Effective teaching and improved learning outcomes rely on student engagement and active learning. Interactive, hands-on approaches are particularly valuable in science education for fostering better comprehension of scientific concepts. This research investigates the efficacy of the drill and practice method to enhance student engagement and learning outcomes in salt hydrolysis. The study follows a classroom action research design across two cycles in a public high school in Sukoharjo Regency, Indonesia. Participants were selected purposively due to identified issues in engagement and academic performance. Data collected via cognitive tests, observations, and questionnaires were analyzed descriptively. Results show that implementing the drill and practice method significantly heightened student engagement in salt hydrolysis, with active student percentage rising from 73% (Cycle I) to 88% (Cycle II). Cognitive learning outcomes also improved, progressing from 67% (Cycle I) to 81% (Cycle II). These findings hold significance for science education. The drill and practice approach enhances engagement and understanding, allowing educators to elevate learning outcomes. This method can cultivate engagement and boost learning in similar contexts, such as high school. By embracing interactive strategies, educators foster active participation, aiding students in mastering scientific concepts and addressing engagement and performance concerns.

Keywords: Drill and practice method, engagement, learning outcomes, salt hydrolysis.

INTRODUCTION

Chemistry teachers often encounter the challenge of effectively teaching complex topics, such as salt hydrolysis, which require differentiated instructional approaches to cater to the diverse learning needs of students. Differentiated instruction has been shown through research to enhance students' conceptual understanding, critical thinking skills, and motivation to learn chemistry (Mahaffy, 2004; Moon et al., 2016). By adapting teaching methods tasks and providing additional support, teachers can successfully improve students' understanding and engagement in chemistry education, including the challenging topic of salt hydrolysis (Susetyo et al., 2021).

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Two instructional approaches, Problem-Based Learning (PBL) and Drill and Practice can create a comprehensive and differentiated learning environment. Problem-based learning engages students in developing critical thinking and problem-solving abilities by analyzing real-world problems related to salt hydrolysis (Aidoo et al., 2016; Wenno et al., 2021). This approach encourages students to think critically and connect concepts within the context of authentic problems (Prikken et al., 2019). On the other hand, Drill and Practice reinforce students' comprehension through repetitive exercises tailored to their individual learning needs, difficulty levels, and pace of understanding (Aidoo et al., 2016). These exercises allow students to solidify their knowledge and skills through practice and repetition (Lehtinen et al., 2017). Previous studies have demonstrated the effectiveness of both Problem-Based Learning and Drill and Practice in enhancing students' understanding of chemistry concepts.

The combination of Problem-Based Learning (PBL) and Drill and Practice in teaching salt hydrolysis is an area that warrants further exploration. While individual merits of PBL and Drill and Practice have been studied (Abdulah & Wangid, 2021; Lufri et al., 2020; Meir & Rätsch, 2003; Mendrofa & Wijaya, 2022; Peen & Arshad, 2017; Zitzewitz & Berger, 1985a), their combined potential in teaching salt hydrolysis remains relatively uncharted. PBL, emphasizing real-world problem solving, and Drill and Practice, centered on repetitive skill reinforcement, each brings unique strengths. PBL cultivates critical thinking and problem-solving skills within real-life contexts (Peen & Arshad, 2017). Conversely, Drill and Practice enhance comprehension and mastery of specific concepts (Zitzewitz & Berger, 1985; Lufri et al., 2020; Mendrofa & Wijaya, 2022; Abdulah & Wangid, 2021). Combining these methods offers the opportunity for comprehensive understanding, practical application, and skill reinforcement. This integrated approach could foster a deeper engagement with salt hydrolysis among students, encouraging active learning and bolstering their academic performance. However, the effectiveness of this combined approach would hinge on the careful design of learning activities and resources. Further research is needed to unveil the full potential of integrating PBL and Drill and Practice for teaching salt hydrolysis.

The novelty of this research lies in its exploration of uncharted territory by integrating Problem-Based Learning and Drill and Practice in the teaching and learning of chemistry, specifically focusing on salt hydrolysis. The findings of this study will offer valuable guidance to educators by providing innovative instructional strategies that can enhance students' engagement and learning outcomes in chemistry education. Additionally, the research will shed light on the potential benefits and challenges of combining these approaches, addressing a significant gap in the current literature.

By investigating the impact of integrating Problem-Based Learning and Drill and Practice on students' understanding, engagement, and mastery of chemistry concepts, the research will contribute to the existing literature by offering novel insights and evidence-based recommendations for effective instructional practices in chemistry education (Yu & Chen, 2014). Furthermore, the study will provide educators with valuable information on how to create inclusive learning environments that cater to the diverse needs of students, ultimately maximizing their learning potential. The findings of this research will contribute to the chemistry education by offering innovative instructional strategies, addressing a significant gap in the current literature, and providing evidence-based recommendations for effective instructional practices in chemistry education.

METHOD

Research Design

This study employs a classroom action research design comprising two cycles (Slameto, 2015). The design incorporates four primary stages: planning, acting, observing, and reflecting. During the planning stage, the researcher will meticulously plan the implementation of the drill and practice method, including the selection of problem variations, practice duration, and feedback strategies tailored to the students (Prihantoro & Hidayat, 2019). The acting stage involves the actual execution of the drill and practice method focused on salt hydrolysis, specifically targeting Grade XI Science Program students in a public school in Sukoharjo Regency.

Subsequently, the observing stage entails a meticulous examination of the student's level of engagement throughout the learning process, careful documentation of teacher-student interactions, and a comprehensive assessment of the student's progress in comprehending the subject matter. Observations will be conducted through direct observation, employing recording devices, and maintaining detailed written records. The reflection stage encompasses an in-depth analysis of the data obtained from the observations, facilitating a comprehensive evaluation of the drill and practice method's implementation. The researcher will scrutinize the data to identify notable changes in student engagement and learning outcomes from the initial to the subsequent cycle.

By employing the classroom action research design, the researcher can systematically apply the drill and practice method, diligently monitor fluctuations in student engagement and learning outcomes, and critically reflect on pedagogical practices. This design ensures data collection directly from the classroom setting, fostering a high degree of relevance between research findings and the authentic learning environment.

Participant

The participants in this study are students enrolled in Grade XI, specifically in Class 01 of the Science Program at a public high school in Sukoharjo Regency, located in the Mojolaban sub-district. The school is identified as "SMA A" for this research. The selection of Class 01 was based on purposive sampling, considering the specific issues of low student engagement in chemistry learning and relatively low academic achievements.

To ensure the sample's representativeness, Class 01 was chosen as it exhibited the identified problems, making it suitable for investigating the effectiveness of the drill and practice method in enhancing student engagement and learning outcomes. By focusing on this particular class, the research aims to address students' challenges in their chemistry learning journey and contribute insights to improve instructional practices. Before the commencement of the study, necessary permissions and consent were obtained from the school authorities and the parents of the participating students. Ethical considerations were strictly adhered to, guaranteeing the protection of student privacy and confidentiality throughout the research process. The collected data will be treated with the utmost confidentiality and used solely for this study. No information potentially identifying individual students will be disclosed without proper consent.

Instrument

Various instruments are used to collect data, including cognitive tests, observations, and questionnaires. The cognitive tests are administered to quantitatively measure students' learning outcomes, specifically focusing on their understanding of concepts related to salt hydrolysis. The validity of these tests has been established through expert validation in chemistry education. The reliability of the tests is assessed using internal consistency measures, such as Cronbach's alpha coefficient, to ensure the reliability of the measurements. Observations are conducted to observe the level of student engagement during drill and practice learning sessions. Trained researchers or designated observers record student behaviors and active participation in learning activities. The observations include participation level, cooperation, perseverance, and active participation in answering questions or completing exercises. Questionnaires are administered to gather students' perspectives on the effectiveness of the drill and practice method. In addition, the questionnaires include items designed to assess students' perceptions and experiences regarding the method's efficacy in facilitating their learning. These instruments provide comprehensive data to evaluate students' learning outcomes and engagement while implementing the drill and practice method in salt hydrolysis.

Data Analysis

This study's data analysis employs descriptive methods to analyze the collected data comprehensively. Qualitative and quantitative data from cognitive tests, observations, and questionnaires are processed and interpreted.

Quantitative data from cognitive tests undergo descriptive statistical calculations, including measures such as mean, median, and percentages. These calculations provide an overview of the student's understanding of the salt hydrolysis material and highlight any changes in their learning outcomes between the first and second cycles.

The observation data are descriptively analyzed to depict the level of student engagement during the drill and practice sessions. This analysis encompasses various aspects, including participation, cooperation, perseverance, and active involvement in answering questions and completing exercises. The descriptive analysis offers insights into the extent of student engagement and any variations observed between the first and second cycles.

Similarly, the data from questionnaires are subjected to descriptive analysis to understand the students' perceptions regarding the effectiveness of the drill and practice method. This analysis involves calculating percentages, averages, or specific scores provided by students in the questionnaire. The results of the descriptive analysis provide a comprehensive understanding of student engagement and learning outcomes following the implementation of the drill and practice method in the salt hydrolysis topic. These findings will be discussed to examine the observed changes and draw conclusions regarding the method's effectiveness in enhancing student engagement and improving learning outcomes in the Grade XI Science Program at a public school in Sukoharjo Regency.

RESULTS AND DISCUSSION

Planning

During the action research (PTK) planning phase, a systematic and targeted approach is undertaken to ensure effective instructional activities. One crucial step in this phase involves conducting initial observations and assessments in non-cognitive and cognitive domains to gauge students' proficiency levels. The non-cognitive assessment helps categorize students as Proficient, Sufficient, or Need Guidance. In addition, it provides valuable insights into their starting points and serves as a baseline for their skills and knowledge (Slameto, 2015).

Similarly, pre-tests in the cognitive domain are administered to assess students' understanding of previous topics. Analyzing these pre-tests enables educators to understand students' cognitive abilities better and classify them as Proficient, Sufficiently Proficient, or Need Guidance. In addition, this analysis plays a vital role in identifying students' strengths and areas that require additional support (Wright et al., 2015).

Once the assessment phase is completed, the next important step in the planning process is the selection of appropriate teaching strategies and materials.

Based on the assessment results, educators can choose instructional methods catering to students' diverse proficiency levels. In this case, the Problem-Based Learning (PBL) approach with Drill and Practice has been selected as a differentiated instructional strategy (Sugiharti et al., 2019). PBL involves presenting students with real-life problems or scenarios to stimulate critical thinking and problem-solving skills. At the same time, Drill and Practice focus on repetitive practice activities to reinforce understanding and mastery (Zitzewitz & Berger, 1985b).

To support the implementation of the PBL approach, Learning and Teaching Materials, such as student worksheets, are developed as supplementary resources. These worksheets provide explanations and trial questions to strengthen students' comprehension and offer opportunities for the practical application of their knowledge. In addition, they serve as comprehensive guides for teachers and students, ensuring a well-structured learning process aligned with the desired learning outcomes (Zitzewitz & Berger, 1985b; Lehtinen et al., 2017).

Educators can make informed decisions regarding suitable teaching strategies and materials catering to students' varying proficiency levels by integrating initial observations, assessments, and analyses into the planning phase. This proactive approach establishes an inclusive learning environment that promotes active engagement, fosters critical thinking, and supports overall academic growth.

Engagement

Based on Figure 1, The data indicates that while students maintained proficiency in most engagement indicators, some areas experienced a decline in the ability to engage sufficiently. For example, oral, Visual, Emotional, Writing, and Mental Activities displayed varying degrees of change across the proficiency levels. These findings highlight the importance of providing guidance and support to students who need it to enhance their overall engagement in the learning process.

The data depicted in Figure 1 emphasizes the importance of considering students' diverse proficiency levels when promoting engagement during the learning process. In addition, it is evident that certain indicators of engagement experienced fluctuations in proficiency levels, indicating the need for further exploration and intervention to enhance student involvement.

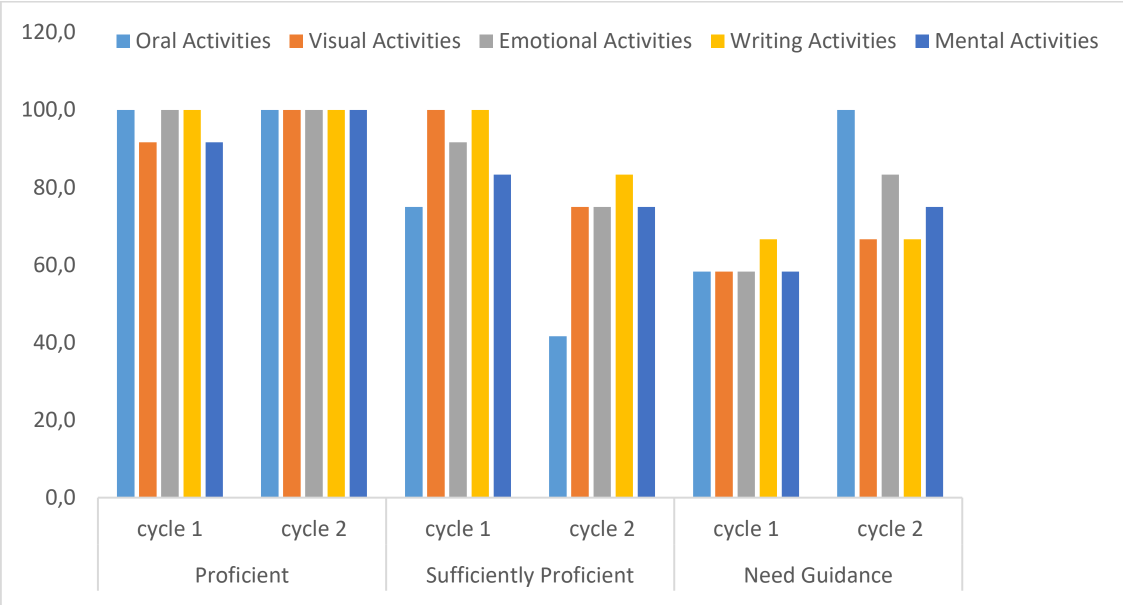


Figure 1. Comparison of Student Engagement Achievement in Cycles I and II.

Research has previously highlighted the significance of providing feedback in fostering student engagement. Feedback is crucial in guiding students' learning and helping them identify areas for improvement (Dubas & Toledo, 2016). The decrease in the Sufficiently Proficient category and the increase in the Need Guidance category across various activities suggest the potential benefits of implementing targeted feedback strategies to address students' specific needs (Tang, 2016).

Furthermore, studies have underscored the concept of learning disabilities and stressed the importance of considering the diverse needs of students in instructional practices. Differentiated instruction involves adapting teaching methods and materials to meet individual student needs and allows educators to provide appropriate challenges and support, promoting higher engagement levels (Jing-Jing, 2014).

Previous research has also explored integrating the "Drill and Practice" approach within the Problem-Based Learning (PBL) framework. PBL emphasizes active learning and critical thinking, and incorporating Drill and Practice activities can enhance students' comprehension and mastery of concepts. In addition, this approach is particularly beneficial for students who require additional guidance and practice to develop their skills and achieve proficiency (Aidoo et al., 2016; Levy & Wilensky, 2009; Peddycord-Liu et al., 2018).

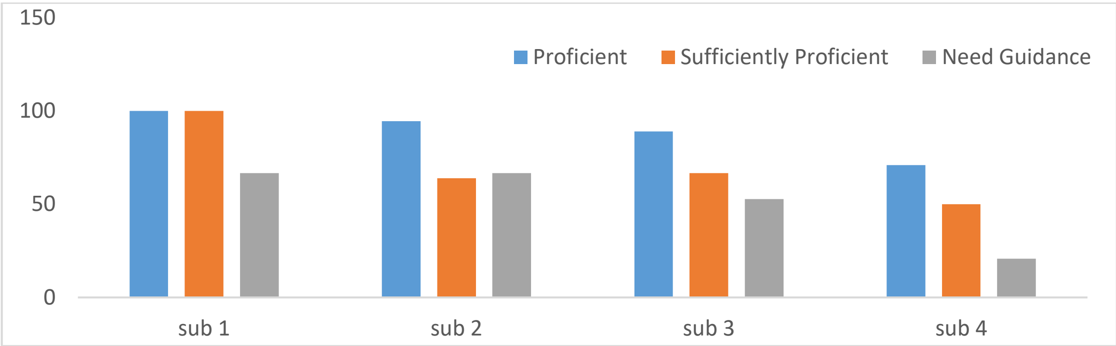
Additionally, the sociocultural theory proposed by Vygotsky highlights the significance of social interactions and scaffolding in learning (Bucat, 2004). By implementing differentiated instruction and incorporating collaborative activities, teachers can create a supportive learning environment that fosters engagement and facilitates peer learning (Moro et al., 2017; Tan et al., 2020).

The data analysis in the table emphasizes the importance of considering different proficiency levels and addressing students' varying needs in the learning process. Strategies such as targeted feedback, differentiated instruction, and integrating "Drill and Practice" within PBL can enhance student engagement and promote proficiency across different proficiency categories. In addition, by drawing on previous research and educational theories, educators can design effective instructional practices that optimize student engagement and support their learning outcomes (Graulich & Caspari, 2021).

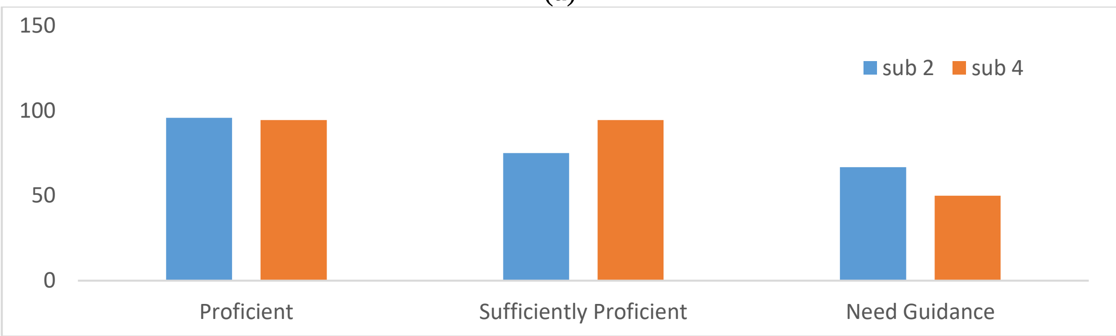
Learning Outcome

Based on the data presented in Figure 2, Cycle 1 of the learning process, they were focused on four subtopics related to hydrolysis reactions and salt properties. The student assessment results showed variations in achievement for each subtopic. The first subtopic, "Types of Hydrolysis Reactions and Salt Properties," had relatively weak effects. Only a small proportion of students achieved satisfactory proficiency in understanding the different types of hydrolysis reactions and the properties of salts (Laliyo et al., 2022). This may be due to the complexity of the concepts and the challenges associated with their application. Conversely, the second and third subtopics, "Calculating pH of Strong Acid and Weak Base Hydrolysis" and "Calculating pH of Weak Acid and Strong Base Hydrolysis," yielded better outcomes. Most students demonstrated adequate proficiency in pH calculations for these hydrolysis reactions (Barke et al., 2009).

However, the fourth subtopic, "Calculating pH of Weak Acid and Weak Base Hydrolysis," also had relatively weak results. Only a few students were proficient in comprehending and calculating pH values for hydrolysis reactions involving weak acids and bases (Çetingül & Geban, 2005).



(a)



(b)

Sub1: Hydrolysis reaction types and salt properties
Sub 2:Calculate the hydrolysis pH of a strong acid, weak base
Sub 3:Calculate the hydrolysis pH of a weak acid, strong base
Sub 4:Calculating the hydrolysis pH of a weak acid, weak base

Figure 2. Histogram of the achievement percentage of learning outcomes in (a) cycle I and (b) cycle II.

In Cycle 2, there was a notable improvement in student achievements across all subtopics. For example, the subtopic "Calculating pH of Strong Acid and Weak Base Hydrolysis" showed a significant increase in the percentage of students achieving an adequate level of proficiency. In addition, the subtopic "Calculating pH of Weak Acid and Weak Base Hydrolysis" also experienced a substantial enhancement in student outcomes. This improvement can be attributed to implementing a differentiated approach that utilized Problem-Based Learning (PBL) and Drill and Practice, supported by Learning Kits and Printed Learning Materials (Student Worksheets). PBL engaged students in relevant problem-solving scenarios, while Drill and Practice, facilitated by Student Worksheets, provided structured exercises and explanations to reinforce understanding (Erna et al., 2021; Ishartono et al., 2016).

Considering students' characteristics, proficient learners could grasp the subtopics effectively. Moderately proficient students may have needed help with more complex situations or applying related principles (Erna et al., 2021; Sugiharti et al., 2019; Voogt, Fisser, et al., 2013). Students requiring guidance struggled with comprehensive concept comprehension and benefited from additional support. The differentiated approach of using PBL, Drill, Practice, and student worksheets as a learning strategy provided the necessary assistance to these students. By tailoring instruction to individual proficiency levels and addressing specific needs, teachers helped students overcome their challenges (Ferrell et al., 2019).

PBL contributed to developing critical thinking and problem-solving skills, which aided in comprehending complex concepts. In addition, it engaged students in real-life situations that demanded analytical thinking and the application of knowledge, helping them establish connections between theory and practical applications (Moon et al., 2017). Drill and Practice, facilitated by student worksheets, allowed students to practice and reinforce their understanding through structured exercises and explanations. These exercises helped students refine their calculation skills and deepen their comprehension of hydrolysis reactions and salt properties. The availability of student worksheets also enabled students to receive prompt feedback, helping them identify errors and make necessary improvements (Ishartono et al., 2016).

Furthermore, student interaction and collaboration in a group learning setting significantly enhanced overall achievement. In PBL settings, students were encouraged to share thoughts, engage in discussions, and exchange information with their peers. This improved their understanding by incorporating diverse perspectives and fostered the development of social skills and cooperation. Another contributing factor to the improvement in student achievement in Cycle 2 was the support and guidance provided by the teacher. Teachers who offered clear directions, explanations, and individual attention assisted students in overcoming difficulties and achieving a better understanding of the subject matter (Feierabend et al., 2011; Xu et al., 2020).

By employing a differentiated approach that combined PBL with Drill and Practice, along with student worksheets, teachers could cater to students' diverse needs and proficiency levels. PBL promotes active engagement, critical thinking, and problem-solving skills (Gallardo-Williams & Dunnagan, 2021; Potkonjak et al., 2016; Rodríguez-Becerra et al., 2020). At the same time, Drill, Practice, and student worksheets provided structured exercises and immediate feedback for students to reinforce their understanding through practice and self-correction. Additionally, the collaborative and interactive nature of PBL fostered peer learning, communication, and the sharing of ideas, creating a supportive learning environment where students learned from each other's perspectives and experiences. It is important to note that the improvement in student achievement depended not solely on the teaching strategies employed but also on factors such as students' willingness to participate, their prior knowledge actively, and their learning styles (Voogt et al., 2013). Continuous assessment and feedback from teachers and students were essential in identifying areas for improvement and tailoring instruction accordingly. Implementing a differentiated approach incorporating PBL, Drill and Practice, and student worksheets has proven effective in enhancing student achievement in the subtopics related to hydrolysis reactions and salt properties. By addressing students' diverse needs, providing opportunities for active engagement, and reinforcing understanding through practice and collaboration, teachers can improve learning outcomes and support the overall academic growth of their students(Moon et al., 2017).

CONCLUSION

The planning phase of action research (PTK) helps ensure a systematic and targeted approach to improve student engagement and learning outcomes. Teachers can select appropriate teaching strategies and materials by observing and assessing students' proficiency levels. Implementing Problem-Based Learning (PBL) with Drill and Practice and supplementary resources like Learning Kits and Printed Learning Materials (Student Worksheets) supports differentiated instruction and addresses students' diverse needs. Analyzing engagement data showed fluctuations in different areas across proficiency levels. To enhance engagement, targeted feedback strategies and differentiated instruction should be used to meet students' specific needs. The learning outcomes analysis revealed variations in student achievements for different subtopics. However, implementing PBL with Drill and Practice, supported by student worksheets, led to notable improvements in student achievement in Cycle 2. PBL promoted critical thinking, while Drill and Practice with student worksheets reinforced understanding. Teachers can encourage engagement, critical thinking, and problem-solving skills by considering individual needs. Ongoing assessment and feedback are crucial for identifying areas of improvement. Using a diffe-rentiated approach, incorporating PBL, Drill and Practice, and Student Worksheet, has proven effective in improving student achievement in hydrolysis reactions and salt properties, supporting overall academic growth. Proactive planning, differentiated ins-truction, and effective teaching strategies help create inclusive learning environ-ments that cater to students' needs and promote academic success. In addition, teachers can optimize student enga-gement, under-standing, and achievement of learning outcomes by addressing varying proficiency levels, providing engaging instruction, and fostering collaboration.

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