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Problem-Based Learning Model Assisted by Interactive Media to Improve Students Higher Order Thinking Skills (HOTS)

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Abstract: This study explores the issue of students' low Higher Order Thinking Skills (HOTS) in Science, specifically on the topic of Acids, Bases, and Salts, in Class VII-5 at UPT SPF SMPN 40 Makassar. The research aims to evaluate how effective the Problem-Based Learning (PBL) model, supported by interactive media, is in improving students' HOTS. It also examines the level of improvement in each learning cycle and assesses the observed HOTS development throughout the study. Additionally, the research seeks to determine whether there is a significant increase in students' HOTS after applying the PBL model with interactive media. This study follows the Classroom Action Research (CAR) methodology, conducted in two cycles that include planning, implementation, observation, and reflection. Data was collected through HOTS test results (quantitative data) and classroom observations (qualitative data). In the pre-cycle stage, none of the students passed the test, with all 30 students falling below the learning criteria. In Cycle I, 18 students passed, while 12 did not, leading to a class-wide learning completion rate of 60%, categorized as low. Classroom observations during this cycle showed a score of 59.58%, considered fair. In Cycle II, all students successfully passed, increasing the success rate to 83.33%, classified as high. Observations also improved, reaching 66.67%, categorized as good. These findings suggest that the use of Problem-Based Learning with interactive media can effectively enhance students' HOTS.

Keywords: Classroom action research; Higher order thinking skills; Interactive media; Problem-based learning; Science education

Introduction

Education is an ongoing process that involves guidance and leadership, encompassing educators, learners, and learning objectives. The core components of education include raising awareness, empowering students, and fostering behavioral change. This study focuses on the implementation of the Merdeka Curriculum, which is designed to provide an enjoyable learning experience, stimulate innovation, and promote critical thinking skills. As part of this curriculum, Natural Sciences (IPA) play a crucial role by providing knowledge related to the natural environment, fostering scientific inquiry through activities like research and ideation (Lestari, 2019). Encouraging science activities that emphasize critical thinking can improve Indonesia's human resources and enhance students' cognitive development, ultimately impacting their overall growth (Zubaidah, 2017).

Science education plays a pivotal role in shaping students' mindset, expanding their understanding, and equipping them with vital life skills. Skills such as observation, prediction, and scientific reasoning are fundamental in the field of science. Historically, scientific advancements have led to the generation of new knowledge, which has been applied on a global scale, driving technological progress (Yuniati, 2014).

Interactive learning media is an approach that utilizes information and communication technology to support

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the learning process. This can include tools like television, books, radio, magazines, and newspapers, which help achieve educational goals through various methods—audio, visual, audio-visual, or print. Interactive learning media actively engages students, encouraging their participation in the learning process. In the digital era, integrating technology into education is essential, and educators must thoughtfully incorporate tools such as computers and the internet to enhance learning in the classroom. Interactive media fosters direct interaction between teachers and students, enriching the educational experience. This type of media often combines elements like graphics, text, audio, video, and animation to create a dynamic learning environment (Rihani et al., 2022).

As the world enters the Fourth Industrial Revolution, characterized by rapid advancements in science and technology, education must also evolve to meet the demands of the 21st century. Both students and teachers are encouraged to integrate advanced technology into their learning and teaching practices. In addition to innovative teaching methods, learning media plays a critical role in creating an interactive and engaging environment that improves student outcomes. One such tool is Canva, an intuitive online platform for visual communication and design. Canva allows users to create engaging educational materials, such as PowerPoint presentations, posters, concept maps, documents, and more, enriched with animations, images, and audio. Its versatility makes Canva a valuable tool for educators (Ferdiansa et al., 2023). According to Kharissidqi & Firmansyah (2022), using Canva as a learning medium offers advantages such as visually appealing designs, enhanced creativity, and improved time efficiency. Educators can leverage Canva to create compelling teaching resources, making lessons more engaging and effective.

A significant issue in science education today is the overemphasis on rote memorization to meet standardized testing requirements. This approach often neglects the development of higher-order cognitive skills and a deeper understanding of scientific concepts, which are necessary for students to address complex real-world challenges (OECD, 2020). Introducing Higher Order Thinking Skills (HOTS) at the secondary school level helps assess students' ability to connect concepts, analyze data, solve problems, evaluate strategies, develop innovative solutions, engage in argumentation, and make informed decisions (Setiawati et al., 2019).

However, Indonesia's education system still faces challenges, as reflected in international assessments like TIMSS (Trends in International Mathematics and Science Study) and PISA (Programme for International Student Assessment). In the 2015 TIMSS survey, Indonesia ranked 45th out of 48 countries, while in PISA rankings, Indonesia placed 6th out of 70 countries in technology skills, reading, and mathematics. These low rankings are attributed to the limited opportunities students have to practice solving complex problems that require advanced thinking skills, such as analysis, evaluation, and creativity (Rahmawati, 2016).

Taufiqurrahman et al. (2023a) defines HOTS as the ability to apply advanced cognitive skills to solve new challenges. HOTS enables individuals to navigate complex situations by analyzing information, identifying problems, evaluating data, and formulating innovative solutions. This cognitive process involves tasks such as concept analysis, inference-making, representation building, and problem-solving. Students' cognitive abilities can be assessed across six levels based on Bloom's Taxonomy: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6).

HOTS can be evaluated using three primary indicators: analyzing, evaluating, and creating (Hasyim & Andreina, 2019). These indicators emphasize that HOTS goes beyond memorization, highlighting the importance of students' ability to analyze concepts, generate creative ideas, and develop innovative solutions. HOTS is cultivated when students connect new information with prior knowledge, restructuring it to achieve specific goals or solve problems (Nafiah & Suyanto, 2014). Thus, training students in HOTS is crucial to developing advanced cognitive skills, including critical thinking, creative problem-solving, and decision-making.

Royantoro et al. (2018) argue that the current educational exercises still fall within the Lower Order Thinking Skills (LOTS) category based on Bloom's taxonomy (Anderson & David, 2001). To develop HOTS, students must be trained to manipulate information and generate new insights. In the cognitive domain, HOTS includes analysis, evaluation, and creation, helping students make connections between what they have learned and what they have yet to encounter (Gunawan, 2003; Preus, 2012).

One effective instructional model for developing HOTS is Problem-Based Learning (PBL). PBL enhances students' problem-solving skills by engaging them in real-world challenges. Through this approach, students actively apply the scientific method to solve problems, fostering deeper learning and the development of HOTS (Kamdi, 2017). Providing students with HOTS training is essential in preparing them for creative and innovative problem-solving (Ramos et al., 2013).

The PBL model focuses on problem-solving. By working through real-life scenarios, students construct knowledge and develop critical thinking skills that can be applied to various contexts (Simamora et al., 2017). Numerous studies have shown that PBL improves students' cognitive abilities, encourages independent

learning, and fosters problem-solving skills (Zabit, 2010). Research at UPT SPF SMPN 40 Makassar has shown that science students have not yet achieved the desired proficiency in HOTS. Traditional teaching methods currently used do not effectively assess students' higher-order thinking abilities. Although teachers observe analytical skills during practical activities, these skills are not adequately evaluated in theoretical assessments, leading to incomplete measurement of students' cognitive abilities.

Discussions with Mrs. Sukmawanty Rahman, a science teacher at the school, revealed that many students struggle with critical thinking skills and require targeted interventions to enhance their cognitive development. Despite teachers' efforts, students often find HOTS-based questions challenging due to limited exposure to critical thinking exercises. Furthermore, there is a lack of training on designing HOTS-oriented questions and implementing PBL models with interactive media. No structured training has been provided in this area.

Observations indicate that 21st-century learning practices have not been fully implemented in the school. The focus remains on cognitive concepts and textbook-based learning, with limited use of technology to meet modern educational demands. Traditional methods contribute to monotonous learning experiences, reducing student engagement and motivation. Many students find science and mathematics difficult and uninteresting (Cooney et al., 1975). To improve students' HOTS, it is crucial to implement an interactive learning model. Integrating PBL and interactive learning media, such as Canva, can enhance students' understanding of scientific concepts and their ability to apply higher-order thinking skills effectively. This study aims to explore the impact of combining these approaches to improve educational outcomes.

Improving the quality of education requires continuous refinement of the curriculum, from the Education Unit Level Curriculum to the 2013 curriculum and its 2017 revision, in response to the challenges of the 21st century (Mufit et al., 2023). Widiandari & Redhana (2021) highlights that 21st-century learning focuses on imparting essential skills to students, such as communication, collaboration, critical thinking, and problem-solving. One of the core characteristics of 21st-century learning is that it equips students with problem-solving skills.

Suwandi et al. (2021) conducted research on the development of a problem-based learning model with a multiple intelligences approach, showing its effectiveness in improving students' problem-solving skills in physics. The success of teachers in guiding students is evident when students achieve optimal results across various subjects, including science. Science is an organized investigation aimed at discovering patterns or regularities in nature. Based on content standards, science education seeks to provide knowledge about nature systematically, not only mastering a collection of facts but also engaging in discovery processes that are applicable in everyday life (Samsudin et al., 2023; Susilawati & Doyan, 2023).

Problem-based learning, a student-centered educational method, promotes self-directed learning, teamwork, and problem-solving skills (Khoirulloh et al., 2024). PBL engages students in real-world problems, improving social skills and critical thinking, as students practice using language for authentic communication. In the 21st century, students must be proficient in critical thinking, problem-solving, creativity, and collaboration (Puig et al., 2020). This model encourages students to engage in deep thinking, analyze problems, and develop solutions through discussions and exploration, making PBL a relevant approach in the context of Indonesian education (Demirel & Dağyar, 2016). The Problem Based Learning (PBL) model has stages or syntax, which directs students to think, analyze, research, and prepare research reports (Sari et al., 2021).

Method

Research design and method should be clearly defined. The chosen method for this research is Classroom Action Research (PTK), conducted at UPT SPF SMPN 40 Makassar in the city of Makassar, South Sulawesi. The participants of the study are seventh-grade students of class VII-5 in the even semester of the academic year 2022-2023. The independent variable is the Problem-Based Learning model assisted by interactive media, while the dependent variable is the level of Higher Order Thinking Skills (HOTS) of the seventh-grade students at UPT SPF SMPN 40 Makassar. To collect data, a cognitive test focusing on HOTS and a learning implementation observation sheet. It is important to note that this research only focuses on the subject of science, particularly on the topic of acids, bases, and salts.

The study employed the Kurt Lewin model, specifically the Classroom Action Research (PTK) model, encompassing four stages: planning, implementation, observation, and reflection. The research took place over two cycles within a singular classroom (Paizaluddin, 2016).

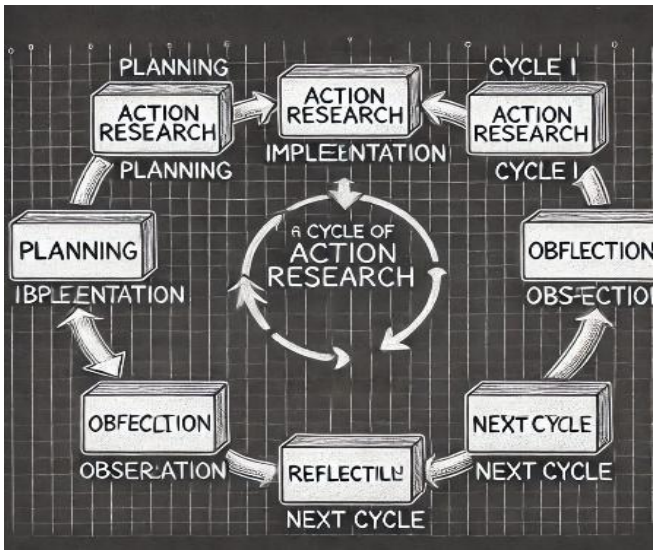

Figure 1. Type of classroom action research (PTK) used

To categorize the improvement of Higher Order Thinking Skills (HOTS) in the Integrated Science subjects, the scores are analyzed using the N-Gain method. The N-Gain formula is applied for this assessment.

$$\text{N} - \text{Gain} = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Maximum score} - \text{Pretest score}} \quad (1)$$

Table 1. N-Gain categories

Score Range	Category
0.7 ≤ N-Gain ≤ 1.0	High
0.3 ≤ N-Gain < 0.7	Medium
N-Gain < 0.3	Low

(Hake, 2002)

The classical mastery calculation utilizes the formula outlined below.

$$\text{P} = \frac{\text{L}}{\text{n}} \times 100\% \quad (2)$$

Description:

P = The percentage of students passing in a classical manner

L = The number of students who pass the Minimum Mastery Criteria 70 (KKM).

n = The total number of students

Descriptive analysis is utilized for data examination, particularly focusing on quantitative data. The mean is calculated, and the results are presented through tables and graphs to illustrate the extent of learning mastery. The minimum completeness criterion (KKM) for students is set at a score of 70. In this study, the success criteria for each cycle are defined by achieving a class average of 70, accompanied by a mastery level of 80% in high-order thinking skills (HOTS). The assessment of the learning process is data collected during teaching and learning activities. To analyze observational data, scores from each indicator are calculated as percentages and then added to obtain the total score. The average percentage score is determined by dividing the total score by the maximum score and multiplying it by 100%. This calculation can be expressed using the following formula.

$$\text{Average score percentage (NR)} = \frac{\text{Total Score}}{\text{Maximum score}} \times 100\% \quad (3)$$

Table 2. Classification of students' HOTS proficiency

Assessment (%)	Criteria
P > 85	Very High
75 < P ≤ 85	High
65 < P ≤ 75	Moderate
55 < P ≤ 65	Low
P ≤ 55	Very Low

(Riduwan, 2013)

Table 3. Observation sheet criteria

Assessment (%)	Criteria
80 % < NR ≤ 100 %	Very good
60 % < NR ≤ 80 %	Good
40 % < NR ≤ 60 %	Fair
20 % < NR ≤ 40 %	Poor
0 % < NR ≤ 20 %	Very poor

(Rosna, 2016)

Result and Discussion

Before commencing the study, the researcher meticulously observed and gathered data regarding the initial state of the class chosen for the research. This specific observation and data collection occurred in class VII-5 at UPT SPF SMPN 40 Makassar during the Even Semester of the Academic Year 2022/2023. Research data was acquired through observation and a test comprising 25 multiple-choice questions on the topic of Acids, Bases, and Salts. This test was administered by the researcher, with observations conducted throughout the learning process in both Cycle I and Cycle II. Prior to assessing students' grades in each cycle, the initial step involved analyzing pre-cycle scores. These scores were assigned to students to evaluate their initial grasp of science learning related to acids, bases, and salts, preceding the implementation of the Problem-Based Learning model with interactive media. Upon completion of the pre-cycle phase, the outcomes were documented in the table below.

Table 4. Displaying the extent of the seventh-grade students' higher-order thinking skills in class VII-5 UPT SPF SMPN 40 Makassar before the cycle

No	Total Students	Percentage (%)	Description
1	0	0	Complete
2	30	100	Incomplete
Total	30	100	

Based on the data provided in Table 4, it is apparent that the Higher Order Thinking Skills (HOTS) of the students are still insufficient. Out of a total of 30 students, none (0%) were able to demonstrate a complete mastery of the subject matter, while all 30 students (100%) failed to achieve the desired level of proficiency. The average score from the pre-test was 55.73, indicating the overall difficulties faced by students in comprehending concepts related to acids, bases, and salts. Throughout the initial phase of this instructional cycle, the percentage of students reaching a satisfactory level of understanding very low, specifically at 0%.

The implementation of planned instructional activities involves the utilization of the Problem-Based Learning model assisted by Interactive Media to enhance Higher Order Thinking Skills (HOTS). The researchers diligently carried out the planned actions using the Problem-Based Learning Model with Interactive Media to promote the development of HOTS. The implementation of actions in Cycle I followed the sequence of the educational process, which includes five stages commonly referred to as the 5M: Observation, Inquiry, Experiment, Reasoning, and Presentation.

At the outset of Cycle I, unexpected challenges emerged. These challenges were rooted in an unpredictable learning environment, marked by disruptive behavior from certain students and limited engagement from others. Only a small number of students actively participated in the teaching and learning activities. The table below provides an overview of the Higher Order Thinking Skills (HOTS) demonstrated by students in Cycle I.

Table 5. Level of higher order thinking skills of seventh-grade students in UPT SPF SMPN 40 Makassar cycle I

Cycle 1	
Mean	62.80
The Number of Students is complete	18
The Number of Students is incomplete	12
Percentage of completion (%)	60
Percentage of incompletion (%)	40

Upon scrutinizing the data presented in Table 5, it is apparent that out of 30 students involved in Cycle I, 18 students successfully concluded Cycle I, while 12 students did not complete Cycle I. This signifies an accomplishment rate of 60% and an incompletion rate of 40%. Proceeding to the analysis of the classical mastery level in Cycle I, the outcomes reveal that 60% of students fall into the low category.

The implementation of the designed learning scenario was observed by an observer who received support from the subject teacher. The primary goal of this observation was to assess whether the actions taken were consistent with the anticipated learning outcomes. The observation carried out in Cycle I reveals that the researcher exhibited competence in executing actions, particularly when employing the Problem-Based Learning model with the assistance of Interactive Media to improve Higher Order Thinking Skills (HOTS). The results of the observation were assessed by the Field Supervisor Lecturer (DPL), Campus Mentor Teacher (GPK), and School Mentor Teacher (GPS).

Table 6. Observation results cycle I

Observer	Observation Results	Percentage (%)	Category
DPL	30	68,18	Good
GPK	26	59.09	Fair
GPS	23	52.27	Fair
Total	79	59.58	Fair

Upon examination of Table 6, it can be inferred that the researcher garnered favorable outcomes from the observation. The DPL observation attained 68.18%, categorized as Good, while the GPK secured 59.09%, falling under the fair category. Furthermore, the GPS observation recorded 52.57%, also classified as Fair. Consequently, it can be assertively stated that the observation outcomes in Cycle I are fair.

After evaluating the outcomes of the Cycle I implementation in the teaching and learning domain, the subsequent observations were made: Reinstating or retraining students' focus during the learning process. Some students still display syntactical inconsistencies. Strive to ensure that all students stay focused during lessons and avoid engaging in any form of play. Continue using worksheets (LKPD) with scanning methods, despite the time-consuming nature. Aim to incorporate ice-breaking activities. The administration of non-cognitive diagnostic assessments takes up a considerable amount of time. The proposed actions for improvement in the second cycle are as follows: Integrate ice-breaking activities. Structure the teaching systematically following syntax. Print Student Activity Sheets (LKPD) and promptly display scanning links to save time. Manage the time effectively during the re-implementation of diagnostic assessments.

After Cycle I was completed, the progress continued to Cycle II because the results of students' Higher Order Thinking Skills (HOTS) were unsatisfactory, failing to reach the mastery level of 80%. Following the predetermined plan, the learning activities proceeded with the implementation of the Problem-Based Learning Model Assisted by Interactive Media, aiming to enhance HOTS. The researcher executed planned actions using the Problem-Based Learning Model assisted by Interactive Media to improve students' high-order thinking skills. The actions taken in Cycle II involved five crucial stages commonly referred to as the 5M: Observing, Questioning, Trying, Reasoning, and Presenting, all of which are

integral components in the scientific learning approach. The table below provides an overview of the Higher Order Thinking Skills (HOTS) results obtained by students during Cycle II.

Table 7. Level of higher order thinking skills of seventh-grade students in UPT SPF SMPN 40 Makassar cycle II

Cycle II	
Mean	73.33
The Number of Students is complete	25
The Number of Students is incomplete	5
Percentage of completion (%)	83.33
Percentage of incompletion (%)	16.67

Upon scrutinizing the data presented in Table 7, it is apparent that out of 30 students involved in Cycle II, 25 students successfully concluded Cycle II, while 5 students did not complete Cycle II. This signifies an accomplishment rate of 83.33% and an incompletion rate of 16.67%. Proceeding to the analysis of the classical mastery level in Cycle II, the outcomes reveal that 83.33% of students fall into the high category.

The implementation of the designed learning scenario was observed by an observer who received support from the subject teacher. The primary goal of this observation was to assess whether the actions taken were consistent with the anticipated learning outcomes. The observation carried out in Cycle II reveals that the researcher exhibited competence in executing actions, particularly when employing the Problem-Based Learning model with the assistance of Interactive Media to improve Higher Order Thinking Skills (HOTS). The results of the observation were assessed by the Field Supervisor Lecturer (DPL), Campus Mentor Teacher (GPK), and School Mentor Teacher (GPS).

Table 8. Observation results cycle II

Observer	Observation Results	Percentage (%)	Category
DPL	33	75	Good
GPK	29	65.91	Good
GPS	26	59.10	Fair
Total	88	66.67	Good

Upon examination of Table 8, it can be inferred that the researcher garnered favorable outcomes from the observation. The DPL observation attained 75%, categorized as Good, while the GPK secured 65.91%, falling under the Good category. Furthermore, the GPS observation recorded 59.10%, also classified as Fair. Consequently, it can be assertively stated that the observation outcomes in Cycle II are Good.

After evaluating the outcomes of the Cycle II implementation in the teaching and learning domain, the subsequent observations were made: Neglecting to provide the opening salutation. Students should be afforded the opportunity to seek additional references on the topic. Students should be given the chance to formulate conclusions on the material, even if there are conclusions in the instructional materials.

The proposed actions for improvement in the future cycle are aimed at enhancing student engagement and the overall effectiveness of the lesson. First, I will begin each class by offering a greeting, such as saying "Good morning" or "Assalamu'alaikum," to create a warm and welcoming atmosphere. This small gesture fosters a positive learning environment and encourages students to feel more connected to the lesson. Additionally, I plan to allocate time for students to seek references before I provide my explanation. This will allow them to form an initial understanding of the material, encouraging curiosity and independent learning. Lastly, I will make sure to set aside time for formulating conclusions throughout the lesson, not just at the end, to help students synthesize and apply the concepts being taught. This approach will also include a review of key points, extending beyond the conclusions provided in the Student Worksheet (LKPD), ensuring that students retain and internalize the learning material effectively.

The data for this study is derived from the scores of objective tests assessing the Higher Order Thinking Skills (HOTS) in Integrated Science for seventh-grade students. These students were instructed using the Problem-Based Learning model with the support of interactive media. The recapitulation of the Classroom Action Research (PTK) calculation for HOTS in Integrated Science can be found in Table 9.

Table 9. Recapitulation of calculation results

	Precycle	Cycle I	Cycle II
Mean	55.73	62.80	73.33
The Number of Students is complete	0	18	25
Percentage of completion (%)	0	60	83.33

The average starting score for class VII-5 on the assessment of Higher Order Thinking Skills (HOTS) was 55.73, as indicated by the information in Table 9. Nevertheless, following the application of the problem-based learning model, the average score rose to 62.80 in Cycle I and further increased to 73.33 in Cycle II. Initially, none of the students could successfully tackle the HOTS questions; however, by Cycle I, the number of students accomplishing this increased to 18, and in Cycle II, it rose further to 25. In terms of percentages, the initial completion rate of 0% is classified as very low. In Cycle I, 60% falls into the low category, whereas in Cycle II, it surges into the high category at 83.33%.

From the data in Table 9, it can be observed that in Cycle 2, the average score has exceeded 70, specifically reaching 73.33. The percentage of students achieving classical mastery has also surpassed 80%, precisely around

83.33%. Therefore, Cycle 2 is concluded as it aligns with the set target. To assess the improvement in this study, N-Gain is calculated. The following is the N-Gain value from this research.

Table 10. Descriptive analysis results of N-Gain for grade VII-5

Cycle	Total of Samples	N−Gain	Category
I	30	0.17	Low
II	30	0.43	Medium
N-Gain		0.30	Medium

Based on the data presented in Table 10, the N-Gain HOTS scores of 30 students in Cycle I fall into the low category, with an average N-Gain of 0.17. These scores indicate that the improvement in Cycle II is also categorized as moderate, with an average N-Gain of 0.43. Therefore, there is a significant increase of 0.30 in the moderate category from Cycle I to Cycle II.

The initial condition for students of class VII-5 at UPT SPF SMP Negeri 40 Makassar indicates a low level of internal KKM mastery or below the KKM threshold (70). This is evident from the pre-cycle result data, showing that no student achieved the KKM score. Upon closer analysis, it was found that teachers were still using traditional teaching methods based on lectures. The instructional material provided to students was also deemed insufficient in motivating active participation, resulting in unsatisfactory HOTS scores. To address this issue, I decided to tackle it by implementing the Problem-Based Learning instructional model, chosen based on the problems identified during observation.

Based on the preliminary assessment of students' grasp of foundational knowledge in Cycle I, it is evident that only 60% of students attained a satisfactory level of comprehension. The outcomes of the HOTS test reveal an overall failure to meet the anticipated performance criteria in Cycle I. Specifically, 12 students fell short of achieving the prescribed mastery level of KKM. This deficiency is attributed to the incomplete optimization by the teacher and lingering disruptions in students' focus during the implementation of the Problem-Based Learning model aided by interactive media. Instances include inadequate introduction of prerequisites, diminished student motivation, insufficient delivery of instructional material, and a lack of satisfactory guidance on HOTS questions. Additionally, classroom observations point to a disruptive learning environment, marked by the presence of a school canteen and the absence of a fan, leading to student discomfort and diminished learning concentration. Some students are disruptive, while others exhibit low engagement levels, with only a handful actively participating in educational activities. To remedy these challenges, researchers must devise solutions, and one viable approach is to proceed with Cycle II using the same Problem-Based Learning model employed in Cycle I.

In Cycle II, the teacher focused more on addressing the identified weaknesses from Cycle I by rectifying the shortcomings observed in the Cycle I reflection. The teacher also instilled enthusiasm within each group during discussions. As a result of these efforts, students in Cycle II achieved a high level of success, with an overall HOTS proficiency rate reaching 83.33%. This accomplishment is attributed to students' confidence in answering questions and their improved ability to grasp the material during the Cycle II phase. Based on the achievement of mastery levels in the science subject during Cycle II, the improvement in learning can be considered successful. Therefore, the implementation of Problem-Based Learning assisted by interactive media on the topic of acids, bases, and salts has proven to be effective in achieving mastery of students' higher-order thinking skills with a high proficiency category. As stated by Taufiqurrahman et al. (2023b), there is progress in classical mastery in every cycle, with improvements observed in cycles IV and V.

Based on the analysis of N-Gain, there was an improvement in N-Gain by 0.17 in the low category during Cycle I, and there was a further increase of 0.43 in the same category during Cycle II. The average N-Gain across both cycles indicates a total improvement of 0.30 with a moderate categorization. The rise in N-Gain scores for students is attributed to the transition from Cycle I to Cycle II, where students started grasping the material, and teachers offered encouragement in the learning process, proving successful in enhancing students' Higher Order Thinking Skills (HOTS) in each cycle. This finding aligns with several studies, including Priyasmika & Ika (2017), which also reported an overall increase in N-Gain scores. Additionally, the research by Riadi (2016) suggests that PBL-based mathematics learning can enhance students' HOTS, particularly in skills such as creating, problem-solving, evaluating, analyzing, and critical thinking. The most significant improvement for students in class VIII SMP Negeri 1 Daha Utara was observed in the skills of evaluating and analyzing, while for students in class VIII SMP Negeri 2 Daha Utara, the primary improvement was in the skill of analyzing. This highlights that PBL-based mathematics learning is effective in enhancing analyzing skills. Moreover, Afandi & Handayani (2020) reveals an enhancement in Higher Order Thinking Skills among students in the subject of Natural Sciences for Elementary School Teachers. Across each cycle, there was an increase of 5 from Cycle I to Cycle II, 6 from Cycle II to Cycle III, and an overall improvement from Cycle I to Cycle III. Kurniasih et al. (2020) research asserts that the Problem-Based Learning (PBL) model, assisted by the KOKAMI (Mystery Box Cards) media, can enhance high-level thinking skills or Higher Order Thinking Skills (HOTS)

and foster collaboration among students in class IV SD Negeri 2 Dukuhwaluh.

Conclusion

The implementation of the Problem-Based Learning (PBL) model, assisted by interactive media, has proven to be effective in developing students' Higher Order Thinking Skills (HOTS) on the topic of acids, bases, and salts in class VII-5 at UPT SPF SMPN 40 Makassar. The research objectives were clearly aligned with enhancing students' cognitive abilities, and the results demonstrate significant improvements across various aspects of HOTS. In Cycle I, the students' mastery of HOTS was still relatively low, with a classical mastery level of 0%, which was categorized as very low. However, after the first cycle, the percentage of students achieving mastery increased to 60%, categorized as low. This indicates progress in students' ability to engage in more complex cognitive tasks. In Cycle II, the percentage increased dramatically to 83.33%, categorized as high, showing substantial improvement in their HOTS, particularly in areas such as analysis, evaluation, and creativity. Additionally, observations during the cycles showed an improvement in the quality of teaching and learning. In Cycle I, the Field Supervisor Observer achieved a score of 30 (68.18%), categorized as Good, indicating solid progress in the application of the PBL model. Other mentors, such as the Campus Mentor Teacher and the School Mentor Teacher, showed satisfactory results, scoring 59.09 and 52.27%, respectively. In Cycle II, all observers noted better outcomes. The Field Supervisor Lecturer received a score of 33 (75%), categorized as Good, while the Campus Mentor Teacher and School Mentor Teacher improved to scores of 65.91 and 59.10%, respectively. These improved observation results reflect a growing proficiency in implementing PBL and interactive media to foster higher-order cognitive skills in students. Overall, the findings from both cycles suggest that the PBL model, combined with interactive media, significantly enhances students' HOTS, particularly in the areas of analysis, evaluation, and problem-solving. This method encourages students to think critically, analyze scientific concepts in depth, and creatively solve problems related to the topic of acids, bases, and salts. The moderate increase of 0.30 in HOTS between Cycles I and II further supports the effectiveness of this approach in promoting deeper cognitive engagement. Therefore, this method can be considered an effective strategy for improving students' critical thinking and problem-solving skills in science education.

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Author Contributions

The authors' contributions to this research include: T. contributes in conceptualization, methodology, software, formal analysis, investigation, resources, data curation, and writing—original draft preparation; S.F. and F.A., who served as supervisors and mentors throughout the study, as well as validators; A.A.A. also acted as a validator and assisted the authors in data management. In addition, he contributed as an external reviewer outside the university. Meanwhile, S.R. served as a mentor teacher, supporting the researchers in the sampling process.

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Conflicts of Interest

The authors declare no conflict of interest.

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