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The Application of Problem-Based Learning (PBL) Accompanied by Crossword Puzzle to Improve The Activity and Learning Outcomes of Physics Students

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Abstrak: Physics learning in grade X of senior high school often faces low student participation and poor learning outcomes, particularly in the topic of measurement. This indicates the need for innovative learning strategies that actively engage students. This study aims to improve student activity and learning outcomes through the implementation of the Problem-Based Learning (PBL) model combined with crossword puzzles. This classroom action research was conducted in class X of SMA Negeri 5 Jember involving 35 students. The learning process was carried out over two meetings in two cycles. Each cycle consisted of planning, implementation, observation, and reflection stages. The results showed that the application of PBL with crossword puzzles improved students' learning outcomes. The N-Gain score increased from 0.60 (moderate category) in the first cycle to 0.76 (high category) in the second cycle. Students' learning activity also improved from the "fair" to the "active" category. Therefore, the implementation of the PBL model combined with crossword puzzles was proven to be effective in enhancing student engagement and learning outcomes in the topic of measurement.
Kata Kunci *:* Problem-Based Learning, Crossword Puzzle, Learning Activity, Learning Outcomes, Measurement

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Introduction

Student learning outcomes are influenced by various factors. According to Wahab in Hidayatullah (2022), these can be classified into internal and external factors. Internal factors include physiological and psychological aspects such as physical condition, intelligence, motivation, and interest. External factors consist of the social environment (community, family, and school) and non-social environment (natural conditions and learning media). Based on observations conducted in class X-2 of SMAN 5 Jember, students' participation in physics lessons was found to be low. Although the Problem-Based Learning (PBL) model was implemented, many students appeared disengaged, silent, bored, and hesitant to interact with the teacher. This aligns with the teacher's observation, which attributes low student activity to the absence of engaging learning media.

Further interviews with physics teachers confirmed that students often interacted socially with peers during lessons, were inattentive, and approached questions carelessly. This led to decreased achievement in physics, evidenced by the average daily test score of 67.05—below the minimum passing grade (KKM) of 75. Students' lack of interest in physics directly impacted their learning outcomes and engagement.

To address this issue, it is necessary to apply innovative learning models that promote student involvement and problem-solving skills. PBL is a model that encourages students to solve real-life problems using their own knowledge and reasoning (Widyasari et al., 2024). Prior studies suggest that combining PBL with varied media, such as PowerPoint, word walls, or interactive books, improves outcomes. One such medium is the crossword puzzle, which promotes active participation and collaborative learning (Siringoringo, 2022). Pasaribu (2021) also supports PBL as a strategy to improve analytical and critical thinking. However, as Hermansyah (2020) noted, the effectiveness of PBL decreases when students are not interested in the subject.

Crossword puzzles have been shown to stimulate memory, enhance vocabulary, and foster curiosity (Permana & Sintia, 2021). Their integration into digital media can enhance the problem-solving process (Safitri et al., 2023) and support communication, data analysis, and creative thinking (Irmayanti & Amalia, 2022). The combination of PBL and crossword puzzles can thus increase retention and motivation by leveraging the fun and challenge of puzzles. Similar findings by Fauzi et al. (2023) showed that game-based PBL improved cognitive learning outcomes.

Therefore, this study aims to improve students' learning activity and outcomes in physics—particularly on the topic of measurement—through the implementation of the Problem-Based Learning model accompanied by crossword puzzles. This approach is expected to foster more engaging and effective classroom learning.

Method

This study employed a Classroom Action Research (CAR) design based on the Hopkins model (1985), which consists of four recurring stages: planning, acting, observing, and reflecting (Muslich, 2011). The research was conducted in two cycles during the odd semester of the 2024/2025 academic year in class X-2 of SMA Negeri 5 Jember, involving 36 students.

Gambar 1 Model Siklus PTK **Hopkins**

Planning Stage.

During this phase, researchers prepared:A lesson plan focused on the topic of measurement, including quantities, units, dimensions, and significant figures.A worksheet (LKPD) that integrated a crossword puzzle activity to reinforce conceptual understanding.Assessment instruments, including:Pretest and posttest: total of 10 multiple-choice questions covering all subtopics.Observation sheet: containing 5 indicators of learning activity, including (1) visual activity, (2) oral/verbal participation, (3) listening attentiveness, (4) writing engagement, and (5) motor activity.Interview guide for students and physics teachers for qualitative insights.Validation of instruments was conducted through expert judgment involving two senior physics education lecturers to ensure content and construct validity.

Acting Stage

The instructional process was implemented over two meetings per cycle. Each meeting began with a 10-minute pretest, followed by a 60-minute PBL session using LKPD and group discussions. A crossword puzzle was completed collaboratively in each group. At the end of the session, a posttest was administered. All sessions were supported by PowerPoint presentations and LCD visuals.

Observing Stage

Three observers were assigned to monitor and document learning activities. Each observer was responsible for two student groups. The observation sheets were filled out using a 4-point Likert scale (very active, active, moderately active, inactive) for the five indicators of learning activities mentioned earlier. Observers also took field notes to capture verbal participation and student responses.

Reflecting Stage

The results of both quantitative and qualitative data were analyzed. For quantitative analysis, students' pretest and posttest scores were compared using N-Gain analysis (Hake, 2002). Learning activity scores were converted into percentages and interpreted based on Sugiyono's (2015) classification.

For qualitative data, student and teacher interviews were analyzed using thematic coding, focusing on recurring themes related to student engagement, motivation, and perceptions of the learning process. Verbatim responses were grouped and interpreted to support the quantitative findings. Triangulation was used to ensure the validity of findings by comparing data from tests, observations, and interviews.

Instrument Reliability and Validity

Instrument reliability was ensured by pilot testing the multiple-choice items on a comparable group of students outside the study class. Cronbach's Alpha was used to measure internal consistency, yielding a value above 0.7, indicating acceptable reliability. Observation sheets were cross-checked among observers to ensure inter-rater agreement.

The analysis of quantitative data will be conducted by examining student activity and learning outcomes. Researchers have determined the mean value for each cycle 1 and cycle 2 using the following equation:

The cognitive learning outcomes of students are measured using pretests and posttests, which yield test scores. The subsequent data analysis employs qualitative descriptive analysis and N-gain analysis:

$$N - Gain = \frac{skor\ posstest - skor\ pretest}{skor\ maksimum\ - pretest}\ x\ 100\% \qquad (1)$$

(Hake., 2002)

then the results are analyzed with the score criteria in table 1 following:

Table 1. Student Learning Outcomes Assessment Criteria

Nilai *N-gain*	Criteria
$\boldsymbol{N - Gain \geq 0,7}$	High
$\boldsymbol{0,3 \leq N - Gain < 0,7}$	Medium
$\boldsymbol{N - Gain < 0,3}$	Low

(Maltzer dan David,2002)

The implementation of learning activities can be assessed through the utilization of an Observation Sheet, which meticulously documents the level of student engagement during the instructional process. This evaluation employs a Likert scale, a psychometric instrument characterized by four-point intervals: "strongly agree," "agree," "disagree," and "strongly disagree.".

The increase in student learning activities was measured using the following equation:

$$Nilai\ Siswa = \frac{Skor\ Perolehan}{Skor\ Maksimum}\ x\ 100\% \qquad (2)$$

(Jihad dan Haris, 2013).

The criteria for assessing student learning activities can be presented in table 2 below:

Table 2. Student learning activity assessment criteria

Percentage Interval (%)	Category
$80 \leq \boldsymbol{P < 100}$	Very Active
$60 \leq \boldsymbol{P < 80}$	Active
$40 \leq \boldsymbol{P < 60}$	Moderately Active
$20 \leq \boldsymbol{P < 40}$	Less Active
$0 \leq \boldsymbol{P < 20}$	Not Active

(Sugiyono,2015)

Results and Discussion

The impetus for this research stems from the challenges encountered by physics educators in the classroom, as evidenced by the suboptimal engagement and performance of students during the learning process. To address these issues, the study employs a multifaceted approach, integrating Problem-Based Learning (PBL) with innovative educational media to enhance student learning outcomes, particularly in the domain of physics measurement. The curriculum encompasses the material on quantities, units, dimensions, and significant figures.The learning process is structured into four distinct stages: planning, action, observation, and reflection. At each meeting, the researcher provides LKPDs accompanied by crossword puzzles and prestest, posttest questions, and has divided each group of six students.

In the initial cycle, researchers conducted the planning stage, which entailed the following: Determining the concept of material, namely LKPD, teaching modules, and student teaching materials, Preparing group formation, Preparing student learning outcomes assessment instruments, Preparing observation sheet instruments. Planning is conducted to prepare for all aspects of the learning process, including the preparation of lesson plans, student questions, and evaluation scoring guidelines. (Hajrah et al., 2021).

Cycle I Analysis

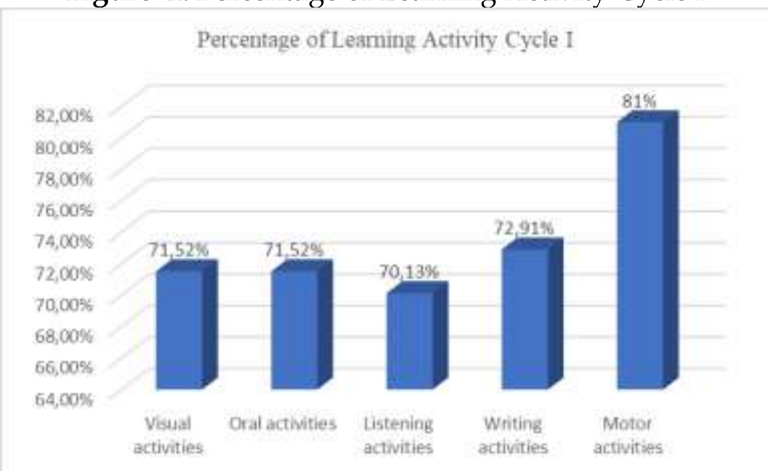
In Cycle I, observation results indicated that students were moderately active in participating in the Problem-Based Learning (PBL) model integrated with crossword puzzles. The average percentage of student learning activity was 73.47%, categorized as active. Among the five activity indicators, motor activity scored the highest at 81% (very active category). This result can be attributed to the hands-on nature of the learning activities, such as filling out crossword puzzles, writing in the worksheet (LKPD), and moving within groups. These tasks demanded higher physical involvement compared to listening or speaking activities. The learning outcome analysis showed an N-Gain score of 0.60, which falls into the moderate category. However, the class average had not yet reached the mastery level set by the minimum completion criteria The implementation of student learning activities from the three observers obtained cycle one percentage data in the following Table 3:

Table 3. Percentage of Students Learninng Activities Cycle I by the Three Observers

No	Activity Indicator	Percentage	Category
1.	*Visual activities*	71,52%	Active
2.	*Oral activities*	71,52%	Active
3.	*Listening activities*	70,13%	Active
4.	*Writing activities*	72,91%	Active
5.	*Motor activities*	81%	Very Active
Average		73,47%	Aktif

The data in the table above shows that 4 indicators of student learning activities have active caterogi and 1 indicator of learning activity gets a very active category can be seen in Figure 2 below:

Figure 2. Percentage of Learning Activity Cycle I



Subsequently, an examination of the learning outcomes of students who completed the pretests and posttests revealed that the majority of students attained a level of completion that met the KKM value of 75. The initial Pretest involved six students, while the Posttest was completed by 30 students. However, 19 students did not complete the Posttest. The data obtained from the students who completed both tests indicates an increase in understanding of PBL learning, although the total completion rate has not yet reached the desired level.The completeness of learning outcomes is illustrated in Table 4 below:

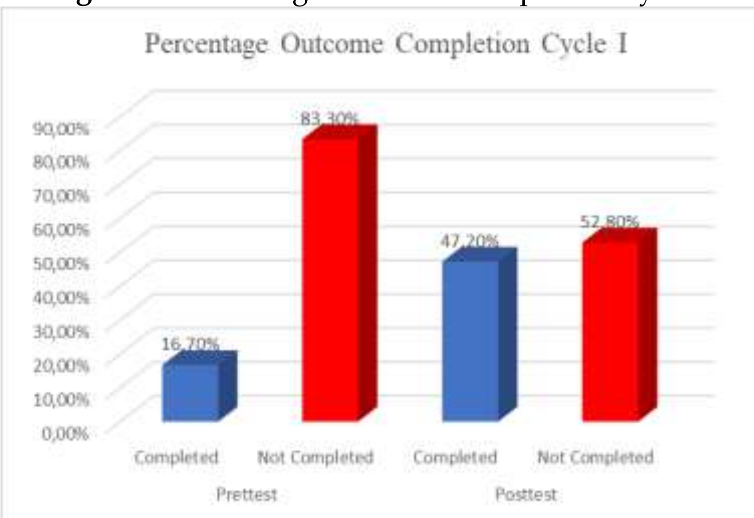
Table 4. Recapitulation of Learning Outcome Completion Score Cycle I

Stage	Completion	Frequency	Percentage	Average

test	*Pret*	Completed	6	16,70%	47,5
		Not Completed	30	83,30%	
test	*Post*	Completed	17	47,20%	80,2
		Not Completed	19	52,80%	

From the table above, it can be seen that the percentage obtained has increased during the prettest and posttest from cycle one can be seen in Figure 3 below:

Figure 3. Percentage Outcome Completion Cycle I



From the data on student completeness in working on *prettest* and *posttest* questions in cycle one, the value of learning outcomes obtained an N-gain score of 0.60 can be seen in table 5 below:

Table 5. Results *N-gain* Cycle I

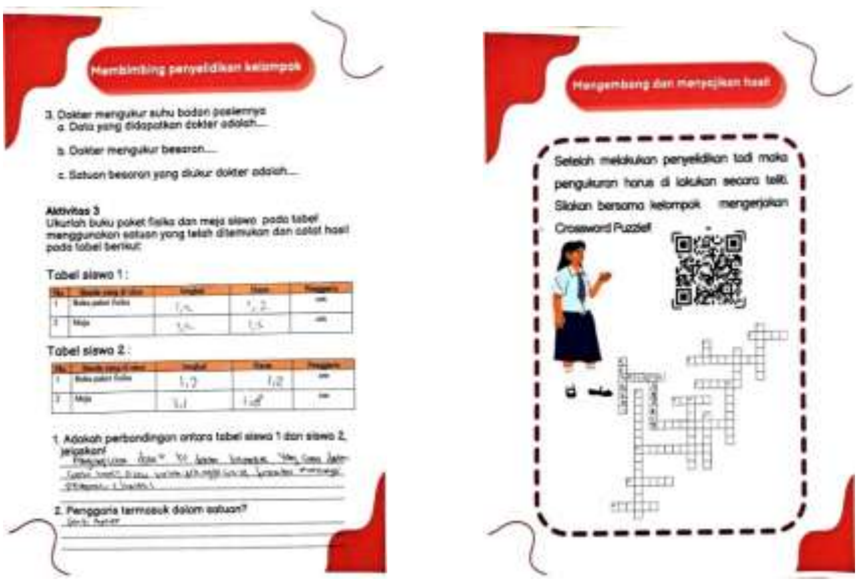
Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
N_GAIN	6	.14	1.00	.6047	.27761
N_GAIN_PERSEN	6	14.29	100.00	60.4773	27.74733
Valid N (listwise)	6				

reflection, the researcher has directed the students to work on LKPD, in which there is also a crossword puzzle that must be completed by the students who have been in their respective groups. According to (Nurhayati, Ermayanti Astuti, 2024) Crossword puzzles are generally considered a form of game, but they also serve a significant educational purpose. In addition to providing entertainment, these games can effectively enhance students' skills. However, in this initial cycle, many students have yet to engage with the learning material, resulting in test scores that do not meet the KKM. Consequently, students can be observed in class as they work on LKPD with their respective groups. The learning activities implemented in cycle one have been assessed, and the results indicate that students have demonstrated a high level of engagement in motor activities, with only a few needing reinforcement. However, in the areas of oral activities, listening activities, visual activities, and writing activities, students are still in the active category, indicating room for improvement. This is due to instances where students engage in self-talk and light-hearted interactions with their group members.The creation of a dynamic and engaging learning environment is crucial for fostering student activity. (Wijaksana, 2021).

This is evidenced by students working on the *Crossword Puzzle* in Figure 5 below:

Figure 4. Students work on Crossword Puzzld Cycle I



This phenomenon is also evident in the learning outcomes, which have been analyzed by obtaining an average of 0.60 with a moderate category. To address the identified weaknesses in the first cycle, researchers will prepare actions in the second cycle

Cycle II Improvement

Based on the reflection from Cycle I, improvements were made by providing verbal and non-verbal reinforcement, as well as modifying the LKPD to promote deeper discussion and student initiative. As a result, in Cycle II, all activity indicators increased to the very active category, with an overall average of 81.80%. Previously lower indicators, such as oral and listening activities, significantly improved due to the teacher's strategy of encouraging structured group discussion and presentations.

Students' learning outcomes also showed significant improvement. The average N-Gain increased to 0.76 (high category), and classical completeness reached 94.4%, indicating the success of the enhancements implemented in the second cycle. The implementation of student learning activities from the three observers obtained cycle one percentage data in the following table 6:

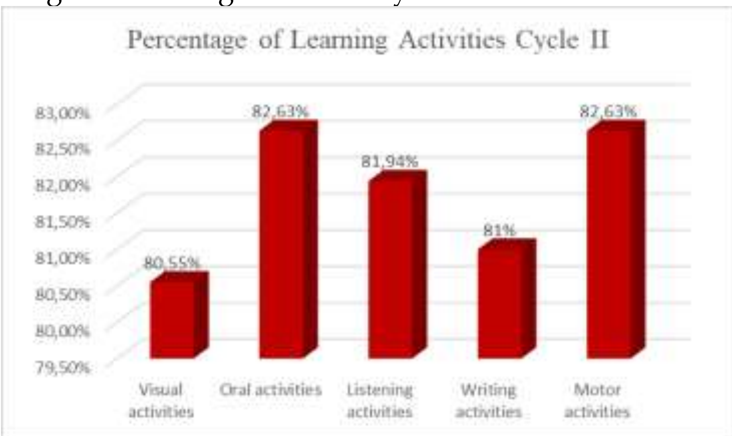
Table 6. Average Percentage of Student Learning Activities Cycle II by the three observers

No	Activity Indicator	Percentage	Category
1.	*Visual activities*	80,55%	Very Active
2.	*Oral activities*	82,63%	Very Active

3.	*Listening activities*	81,94%	Very Active
4.	*Writing activities*	81%	Very Active
5.	*Motor activities*	82,63%	Very Active
Rerata		81,80%	Very Active

The data in the table above shows that the five indicators of student learning activities that have a very active category can be seen in Figure 6 below:

Figure 5. Percentage of Learning Activities Cycle II



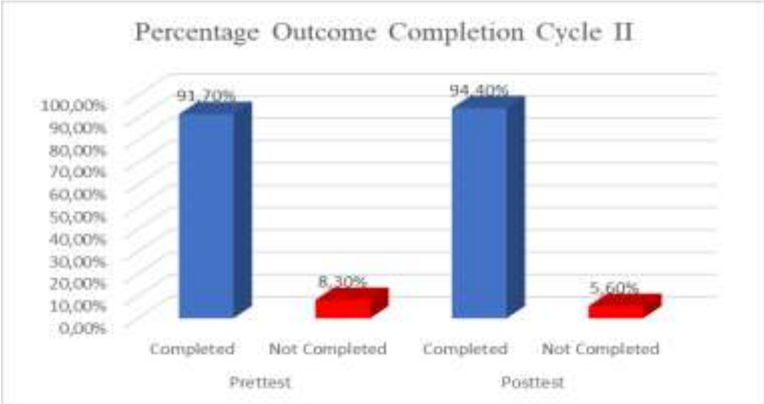
The results of the pretest and posttest indicate that students demonstrated a level of completion that met the KKM value of 75. However, it was observed that only 33 students in class X2 achieved the KKM value, as indicated by an average score of 86.61 and a classical amount of 91.70% on the pretest. The results of the posttest demonstrate that 34 students achieved a completeness rate of 94.40%, indicating a significant increase in the number of students who reached the KKM value of 75. This enhancement was attributed to the implementation of reinforcement through verbal and non-verbal means, which resulted in an average completeness rate of 100%. Data on the completeness of learning outcomes can be seen in table 7 below:

Table 7. Learning Outcome Completeness Score Cycle II

Stage	Completion	Frequency	Percentage	Average
Prettest	Completed	33	91,70%	86,61
	Not Completed	3	8,30%	
Posttest	Completed	34	94,40%	96,05
	Not Completed	2	5,60%	

From the table above, it can be seen that the percentage obtained has increased during the prettest and posttest. The average classical completeness increased to a high category can be seen in Figure 7 below:

Figure 6. Percentage Outcome Completion Cycle II



From the data on student completeness in working on prettest and posttest questions in cycle one, the value of learning outcomes obtained an N-gain score of 0.76 can be seen in table 8 below:

Table 8. N-gain Results Cycle II

Descriptive Statistics

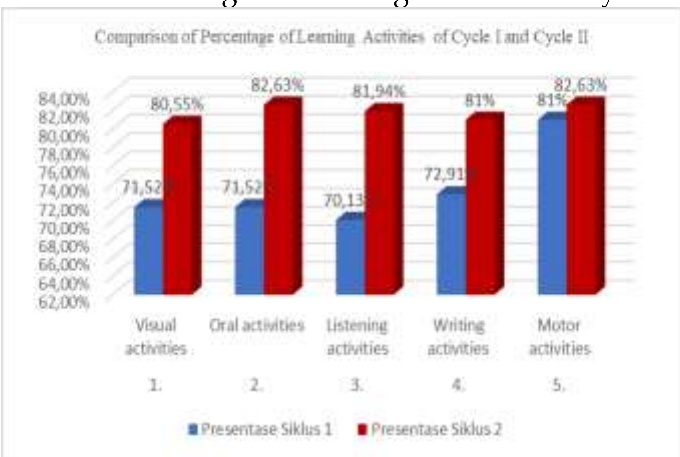
	N	Minimum	Maximum	Mean	Std. Deviation
N_GAIN	6	.00	1.00	.7678	.29978
N_GAIN_PERSEN	6	.00	100.00	76.7791	29.97831
Valid N (listwise)	6				

The final stage is one of reflection, during which the results of the observation are reviewed. The average student learning activity has been determined to be in the very active category, with an average of 81.80%.Based on the completeness data from cycle one that has not yet reached the KKM, verbal and non-verbal reinforcement is implemented for students in the cycle. This is necessary to facilitate problem-solving and understanding of problem-solving (Sari et al., 2024). Students understand better, are active in group discussions by working on LKPD in detail and correctly and are active to dare to come forward to fill in the Crossword Puzzle on the LCD screen in front as shown in Figure 9 below:

Figure 7. Students work on Crossword Puzzld Cycle II

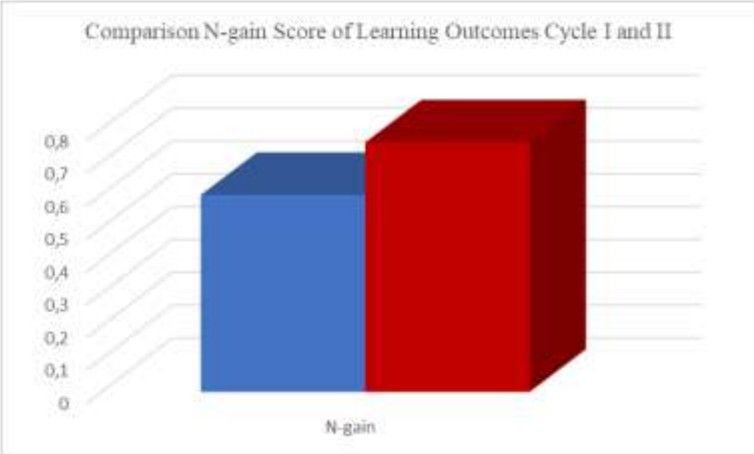
In accordance with the implementation of cycles one and two, a comparison of the results of research on student learning activities and outcomes is warranted. In this case, cycle one still requires improvement in terms of the completeness of activities and learning outcomes. However, cycle two has increased these outcomes.The recapitulation of the results of learning activity research with PBL accompanied by Crossword Puzzle in each cycle can be seen in Figure 10 below:

Figure 8. Comparison of Percentage of Learning Activities of Cycle I and Cycle II



As demonstrated by the data presented above, an increase in learning activities has been observed, which has concomitantly led to an increase in learning outcomes. Initially, these outcomes were medium category, and in cycle two, they increased, as evidenced by the comparison of the completeness of learning outcomes for each cycle in Figure 11 below:

Figure 9. Comparison *N-gain* Score of Learning Outcomes Cycle I and II



These findings are consistent with the research of Siringoringo (2022), which found that crossword puzzle learning strategies fostered collaborative learning and student engagement. Similarly, Permana and Sintia (2021) concluded that crossword puzzles enhance memory retention and stimulate interest through enjoyable learning formats.

The notably high result in motor activities also supports the findings of Irmayanti and Amalia (2022), who explained that physical interaction while solving puzzles stimulates memory and analytical processing simultaneously. Thus, the integration of crossword puzzles into PBL is effective in fostering various aspects of student engagement.

Furthermore, this aligns with Fauzi et al. (2023), who reported that combining PBL with educational games significantly improved students' cognitive learning outcomes. The use of interactive and game-based media within PBL supports a deeper and more meaningful learning experience, especially in physics topics that are traditionally perceived as abstract and difficult.

Conclusion

This study demonstrates that the integration of the Problem-Based Learning (PBL) model with crossword puzzle media effectively improves both student engagement and learning outcomes in physics, particularly in the topic of measurement. The application of this combined approach in two learning cycles resulted in a significant increase in both activity indicators and learning completeness, as reflected in the N-Gain scores of 0.60 in Cycle I and 0.76 in Cycle II. The findings imply that active and game-based learning media can serve as powerful tools to support conceptual understanding in science education. By encouraging students to engage cognitively, socially, and physically, such media enrich the learning process and make abstract content more accessible. Future research should explore the integration of other interactive or digital learning media with the PBL model across different physics topics or educational levels. Moreover, a deeper investigation into the long-term retention effects and individual student response variability would provide broader insights into the effectiveness of these strategies.

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