



Changes in Fifth-Grade Students' Conceptual Understanding of IPAS and Learning Independence Through Matching Puzzle Learning Media

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Abstract

This study was motivated by the low levels of students' conceptual understanding and learning independence. Consequently, there is a need for instructional innovation through the implementation of learning media capable of fostering a more active and meaningful learning process. This study aimed to examine changes in fifth-grade students' conceptual understanding of IPAS and learning independence following the implementation of Matching Puzzle learning media. A quantitative approach was employed using a pre-experimental method with a One-Group Pretest-Posttest design. The study involved 26 fifth-grade students from UPTD SDN Batangan 1. Data were collected through a conceptual-understanding test and a learning-independence questionnaire, both of which had undergone validity and reliability testing. The data were analyzed using the Shapiro-Wilk normality test on the pretest-posttest difference scores. The Wilcoxon signed-rank test was used for conceptual understanding because the difference scores were not normally distributed, while the paired-samples t-test was used for learning independence because the difference scores were normally distributed. The results showed a significant difference in students' conceptual understanding based on the Wilcoxon signed-rank test ($p = .001$). The mean conceptual-understanding score increased from 34.61 in the pretest to 92.30 in the posttest. The paired-samples t-test also showed a significant difference in learning independence ($p = .001$), with the mean score increasing from 17.30 to 30.11. These findings indicate changes in students' conceptual understanding and learning independence following the implementation of Matching Puzzle learning media in Grade V IPAS learning.

Keywords: Conceptual Understanding, IPAS, Learning Independence, Matching Puzzle, Elementary School



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Introduction

Education is carried out through a learning atmosphere and learning process that allows students to actively improve their abilities. This aims to enable them to develop self-control, build a strong personality, develop intelligence, instill noble values, and acquire the skills needed by themselves and the surrounding community (Daulay, 2016). In its implementation, learning not only aims to improve learning outcomes but also

develops students' conceptual understanding and learning independence, enabling them to regulate their own learning process effectively (Aulia et al., 2019; Laksana & Hadijah, 2019). In the Indonesian Kurikulum Merdeka, these competencies are particularly emphasized in Ilmu Pengetahuan Alam dan Sosial (IPAS), translated as Integrated Natural and Social Sciences, where students are encouraged to observe, investigate, and construct concepts through meaningful learning experiences in order to develop scientific thinking and problem-solving skills (Safitri et al., 2024).

Teachers have an important role in the learning process, particularly in IPAS learning. Teachers need to adjust to their new role as motivators and facilitators, in line with the concept of modern learning that views teachers as companions and learning guides, not just material presenters (Hamadi et al., 2018). However, in reality, the learning process in some schools is still teacher-centered with the continuous use of lecture and assignment methods. This condition causes some students to have difficulty understanding the material because they feel bored, lack of attention, and lack of activity during learning activities.

According to the *Programme for International Student Assessment (PISA) 2022* released by the OECD, the average global score declined as a result of disruptions caused by the COVID-19 pandemic. Indonesia ranked 69th out of 80 participating countries with a science literacy score of 383. This achievement is still below the OECD country average and the international average (OECD, 2023). Although PISA assesses approximately 15-year-old students rather than elementary school students, its findings provide a macro-level overview of national scientific literacy and indicate continuing challenges in science education. This suggests the need to strengthen students' scientific literacy from the early stages of education, including at the elementary school level. Low scientific literacy may limit students' ability to apply knowledge creatively, solve problems, and make informed decisions (Yusmar & Fadilah, 2023).

This condition is also reflected in the findings of a preliminary study conducted before the main research. On June 20, 2025, a face-to-face interview was conducted with the fifth-grade homeroom teacher at UPTD SDN Batangan 1 to identify problems related to students' conceptual understanding and learning independence in IPAS learning. The interview was conducted without a formal written instrument and focused on the teacher's observations of students' learning conditions and difficulties. The interview revealed that the learning process was still dominated by lectures and assignments,

causing some students to be less active, easily bored, and experience difficulties in understanding the learning material. This condition was also reflected in the students' daily test results, which showed an average score of 61.5, below the minimum mastery criterion (KKM) of 75. Of the 26 students, 9 achieved the KKM, while 17 students did not. These preliminary findings indicated the need for more innovative, engaging, and student-centered learning media to support students' conceptual understanding and learning independence.

The daily test and the research pretest served different purposes and assessed different learning content. The daily test was a teacher-developed assessment covering material that had previously been taught in the classroom, whereas the pretest was a research instrument designed to assess students' initial conceptual understanding of the IPAS topic investigated in this study before the implementation of Matching Puzzle learning media. Therefore, the daily test results were used as preliminary evidence of the learning problem, while the pretest results served as the baseline measurement for the main research.

To make the learning atmosphere more interesting and entertaining, teachers need various variations in the use of learning media ([Amananda et al., 2025](#)). One of the instructional media that can be used is the matching puzzle learning media. This type of learning media is designed based on the principle of matching related images, words, or concepts, allowing students to actively construct knowledge through interactive matching activities ([Pangastuti, 2019](#)). By combining game elements with creative thinking activities, Matching Puzzle encourages students not only to receive information passively but also to actively identify relationships between concepts and find appropriate matches ([Nurfathiyyah et al., 2025](#)). The implementation of Matching Puzzle learning media at the elementary school level can enhance students' conceptual understanding by encouraging them to think critically and understand the relationships among concepts during matching activities ([Ginting & Barokah, 2025](#)). In addition, this media promotes students' learning independence because they are encouraged to complete tasks independently, make decisions, and develop strategies to find the correct matches during puzzle activities ([Ramlah et al., 2022](#)). Puzzle media is a form of learning media that presents learning materials in the form of image or information pieces that can be arranged, disassembled, and reassembled to facilitate meaningful learning experiences ([Pangastuti, 2019](#)).

In line with previous studies conducted by [Valentine \(2023\)](#), [Ginting & Barokah \(2025\)](#) and [Nurfathiyyah et al. \(2025\)](#), the use of puzzle-based learning media has great potential to improve students' learning outcomes, critical thinking skills, and engagement in science-related learning, particularly at the elementary school level. Puzzle-based learning encourages students to actively participate in learning activities while strengthening conceptual understanding through interactive learning experiences ([Ginting & Barokah, 2025](#)). However, most previous studies primarily focused on learning outcomes, critical thinking, or learning engagement. Although previous studies have demonstrated the effectiveness of puzzle-based learning media, limited studies have simultaneously examined students' conceptual understanding and learning independence in IPAS learning at the elementary school level.

Based on this description, this study was conducted to examine changes in students' conceptual understanding and learning independence following the implementation of Matching Puzzle learning media in Grade V IPAS learning.

The contribution of this research lies in the application of Matching Puzzle media in IPAS learning for fifth-grade elementary school students. Previous studies have examined the use of puzzle-based learning media to support learning outcomes, critical thinking skills, and student engagement ([Ginting & Barokah, 2025](#); [Nurfathiyyah et al., 2025](#); [Valentine, 2023](#)). Building on these studies, the present research applies Matching Puzzle media through interactive matching activities and examines its use in supporting students' conceptual understanding and learning independence in IPAS learning.

Research Method

This study employed a quantitative approach to analyze numerical data and examine differences between pretest and posttest scores ([Liana et al., 2023](#)). The research design was a one-group pretest-posttest design, which is a pre-experimental design involving measurements before and after the treatment. This design consists of three stages, namely pretest, treatment, and posttest, to examine changes in students' scores following the implementation of the learning media.

The research was carried out at UPTD SDN Batangan 1, which is located in Batangan Village, Tanah Merah District, Bangkalan Regency, East Java Province, Indonesia. The selection of the research location was based on the identified problems related to students' conceptual understanding and learning independence in IPAS

learning. The research involved all 26 fifth-grade students at UPTD SDN Batangan 1, consisting of 15 male and 11 female students, with an average age of approximately 11 years. The inclusion criterion was that the participants were fifth-grade students enrolled at the school. Before the main research was conducted, an instrument trial was carried out at UPTD SDN Batangan 2 because of its proximity to UPTD SDN Batangan 1. The trial involved 26 fifth-grade students and was conducted to assess the validity and reliability of the research instruments, which consisted of a conceptual-understanding test and a learning-independence questionnaire. The students involved in the instrument trial were not included in the main research sample. After the instruments were declared suitable for use, the main research was conducted at UPTD SDN Batangan 1. The instruments were administered before and after the implementation of Matching Puzzle learning media to measure changes in students' conceptual understanding and learning independence.

Before the main study, the research instruments were tested on 26 fifth-grade students at UPTD SDN Batangan 2. The school was selected because of its proximity to UPTD SDN Batangan 1. The instrument trial was conducted to assess the validity and reliability of the conceptual-understanding test and learning-independence questionnaire. The students involved in the instrument trial were not included in the main research sample. Although the number of participants in the instrument trial was relatively limited for robust psychometric testing, the trial provided preliminary evidence regarding the validity and reliability of the research instruments.

The conceptual-understanding test consisted of 25 multiple-choice items covering the human respiratory system. The items were developed based on five indicators: identifying respiratory organs, explaining the functions of respiratory organs, explaining the respiratory process, relating respiratory organs to their functions, and analyzing respiratory system disorders. The items covered four cognitive levels: C1 (Remembering), C2 (Understanding), C3 (Applying), and C4 (Analyzing). The blueprint of the conceptual understanding test, detailing the indicators, cognitive levels, and distribution of item numbers, is presented in Table 1. Each item had the same weight, with 4 points awarded for a correct answer and 0 points for an incorrect answer, resulting in a maximum score of 100. Different but equivalent sets of questions were used for the pretest and posttest, with the same indicators and cognitive levels and comparable levels of difficulty.

Table 1 Blueprint of the Conceptual Understanding Test

No.	Indicator of Conceptual Understanding	Cognitive Level	Item Numbers	Number of Items
1	Identifying respiratory organs	C1 - Remembering	1, 2, 3, 4, 5	5
2	Explaining the functions of respiratory organs	C2 - Understanding	6, 7, 8, 9, 10	5
3	Explaining the respiratory process	C2 - Understanding	11, 12, 13, 14, 15	5
4	Relating respiratory organs to their functions	C3 - Applying	16, 17, 18, 19, 20	5
5	Analyzing respiratory system disorders	C4 - Analyzing	21, 22, 23, 24, 25	5

Each item was scored 4 points for a correct answer and 0 points for an incorrect answer, resulting in a maximum score of 100. Different but equivalent sets of questions were used for the pretest and posttest, with the same indicators and cognitive levels and comparable levels of difficulty.

The Matching Puzzle learning media consisted of picture cards related to the human respiratory system. The media used eight pictures, with each picture paired with its corresponding name. Students were divided into groups of five to six students. The learning activity began with the teacher explaining the human respiratory system and introducing the Matching Puzzle activity and its rules. Students then worked in groups and took turns coming to the front of the class to identify the picture that corresponded to the given name and attach the selected picture to the board. After the matching activity was completed, the teacher and students checked the results together, followed by discussion and reinforcement of the learning material. Before the implementation of the Matching Puzzle media, students completed a pretest and a learning-independence questionnaire on June 23, 2025. The Matching Puzzle media was implemented in IPAS learning in two sessions, conducted on June 30 and July 6, 2025, with each session lasting approximately 45 minutes. After the two Matching Puzzle sessions were completed, students completed a posttest and a final learning-independence questionnaire on July 14, 2025. The pretest and posttest used different but equivalent sets of questions based on the same learning indicators and cognitive levels, with comparable levels of difficulty. The use of different question sets was intended to minimize potential recall and practice effects.

The data analysis technique in this study was carried out through several stages. The first stage was a validity test to determine the accuracy of the research instruments in measuring the variables under study. The second stage was a reliability test to assess

the consistency of the research instruments (Sobiri & Nashrullah, 2026). Furthermore, a normality test was conducted using the Shapiro-Wilk test on the pretest-posttest difference scores. For variables with normally distributed difference scores, the paired-samples t-test was used to determine whether there was a significant difference between the pretest and posttest scores. For variables with non-normally distributed difference scores, the Wilcoxon signed-rank test was used. These analyses were conducted to determine whether there were significant differences in students' conceptual understanding and learning independence before and after the implementation of Matching Puzzle learning media in Grade V IPAS learning.

Results and Discussion

Conceptual Understanding

Students' conceptual-understanding data were obtained from the *pretest* and *posttest*. The questions are arranged according to learning indicators which aim to measure the level of students' understanding of the material learned. The test results were then analyzed to determine changes in students' understanding after the implementation of the Matching Puzzle learning media. A comparison of the average pretest and posttest scores for conceptual understanding is presented in Figure 1.

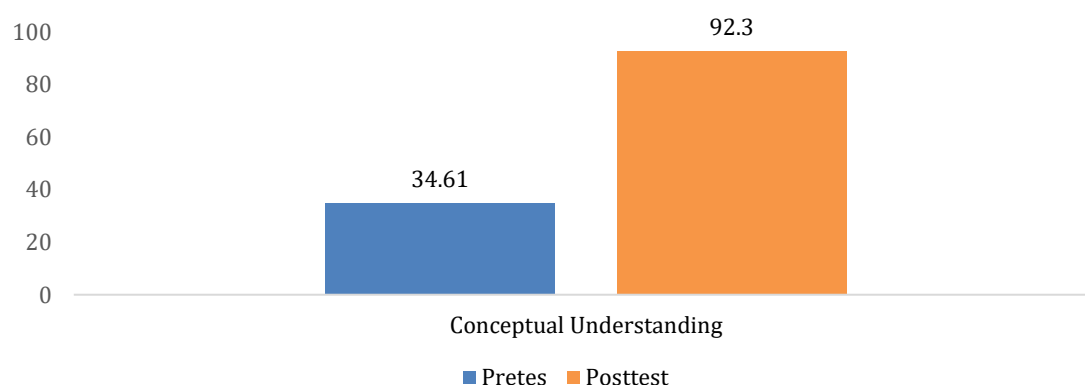


Figure 1 Comparison of Pretest and Posttest Conceptual Understanding

Based on the diagram above (Figure 1), it is known that the average conceptual-understanding score increased from 34.61 in the pretest to 92.30 in the posttest. The results of the pretest showed that all students obtained a score below the Minimum Completeness Criteria (KKM) set, which was 75. However, after being treated using matching puzzle learning media, the posttest results showed that almost all students had achieved scores above the KKM. Only two students did not reach the KKM. These

results show an increase in students' conceptual understanding following the implementation of matching puzzle learning media in IPAS learning.

To determine the appropriate statistical test, a normality test was conducted on the conceptual understanding difference scores. The results of the Shapiro-Wilk normality test for conceptual understanding are presented in Table 2.

Table 2 Normality Test Results for Conceptual Understanding

<i>Shapiro-Wilk Normality Test</i>	
Conceptual Understanding Difference	
N	26
Shapiro-Wilk	.847
df	26
Sig.	.001
a. The difference scores were not normally distributed.	
b. Calculated from data.	

Based on the *Shapiro Wilk* normality test shown in Table 2, the conceptual-understanding difference scores obtained a significance value of 0.001, which was lower than 0.05. Therefore, the difference scores were not normally distributed. Consequently, the Wilcoxon signed-rank test was used to examine the difference between students' pretest and posttest conceptual-understanding scores. The results of the Wilcoxon signed-rank test for conceptual understanding are presented in Table 3.

Table 3 Wilcoxon Signed-Rank Test Results for Conceptual Understanding

<i>Wilcoxon Signed-Rank Test</i>			
Pair	Test Statistic (W)	N	Sig. (2-tailed)
Comprehension Pretest - Comprehension Posttest	0.000	26	.001

Based on the Wilcoxon signed-rank test results in Table 3, the significance value was $p = 0.001$, which was lower than 0.05. This result indicates a statistically significant difference between students' conceptual-understanding scores before and after the implementation of Matching Puzzle learning media. The average conceptual-understanding score increased from 34.61 in the pretest to 92.30 in the posttest. These findings indicate that students demonstrated higher levels of conceptual understanding following the implementation of Matching Puzzle learning media in IPAS learning.

The interpretation of these findings is also supported by the validity and reliability of the research instrument used to measure students' conceptual understanding. Based on the validity test, all conceptual-understanding test items were

declared valid because their calculated r-values exceeded the critical r-value of 0.388. In addition, the reliability test showed a Cronbach's alpha coefficient of 0.922, indicating high internal consistency because it exceeded the commonly accepted threshold of 0.70. These results indicate that the instrument demonstrated adequate validity and high internal consistency for measuring students' conceptual understanding. The significant improvement in students' conceptual understanding can be interpreted from a constructivist perspective, which emphasizes students' active involvement in constructing knowledge through exploration, discussion, and meaningful learning experiences (Handoyo & Ani, 2025).

Through matching activities, Matching Puzzle learning media provides opportunities for students to organize information, identify relationships among concepts, and solve problems collaboratively. This finding is consistent with previous studies showing that puzzle-based learning media can support students' conceptual understanding (Ginting & Barokah, 2025; Valentine, 2023), while interactive learning media can enhance students' critical thinking skills and engagement during the learning process (Amananda et al., 2025). Therefore, the implementation of Matching Puzzle learning media may support students in constructing and connecting IPAS concepts through active and meaningful learning experiences.

Learning Independence

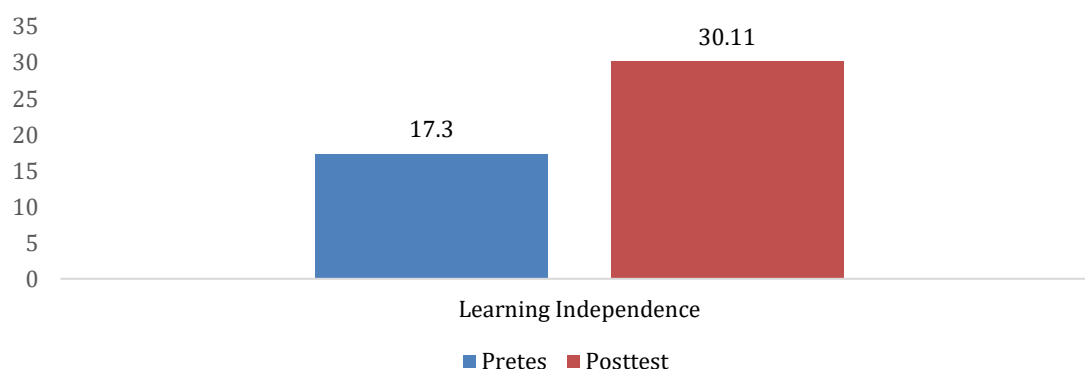
The learning-independence questionnaire consisted of 10 statements measured using a four-point Likert scale. The response options were Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). All items were positively worded, with higher total scores indicating higher levels of learning independence. The learning-independence scores were classified using equal

class intervals based on the range of possible scores, following the statistical principle described by Sudjana (2005). The interval width was calculated using the formula $I = (X_{max} - X_{min})/k$, where I is the interval width, X_{max} is the maximum possible score, X_{min} is the minimum possible score, and k is the number of categories. Thus, $I = (40 - 10)/4 = 7.5$. Based on this calculation, the learning-independence scores were classified into four categories, namely Not Independent, Low Independence, Moderate Independence, and Very High Independence. The complete classification of scores is shown in Table 4.

Table 4 Learning Independence Score Classification

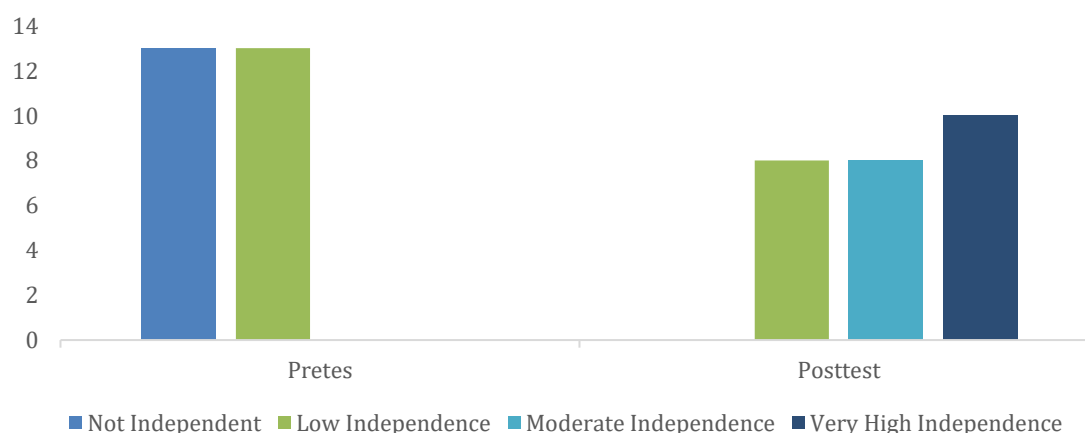
Score Interval	Category
10–17	Not Independent
18–25	Low Independence
26–32	Moderate Independence
33–40	Very High Independence

The comparison of the average pretest and posttest scores for learning independence is presented in Figure 2.


Figure 2 Comparison of Pretest and Posttest Learning Independence Scores

Based on the diagram in Figure 2, the average learning-independence score increased from 17.30 in the pretest to 30.11 in the posttest. This shows an increase in the level of independence of students after the implementation of *Matching Puzzle* learning media. The increase suggests that the media effectively encourages students to become more active, confident, and responsible during the learning process.

Furthermore, the distribution of students across the learning independence categories before and after the intervention is presented in Figure 3.


Figure 3 Distribution of Students by Learning Independence Category

Based on the results of the learning independence questionnaire shown in Figure 3, the distribution of students' learning independence changed after the implementation of Matching Puzzle learning media. In the pretest, 13 students were classified as Not Independent and 13 students were classified as Low Independence, while no students were classified as Moderate Independence or Very High Independence. In the posttest, 8 students were classified as Low Independence, 8 students as Moderate Independence, and 10 students as Very High Independence, while no students were classified as Not Independent. This distribution indicates a shift toward higher levels of learning independence following the implementation of Matching Puzzle learning media.

To determine the appropriate statistical test for learning independence, a normality test was conducted on the difference scores. The results of the Shapiro-Wilk normality test for learning independence are presented in Table 5.

Table 5 Results of the Learning Independence Normality Test

<i>Shapiro-Wilk Normality Test</i>	
	Learning Independence Difference
N	26
Shapiro-Wilk	.963
df	26
Sig.	.446
a. Test distribution is Normal.	
b. Calculated from data.	

Based on the *Shapiro-Wilk* normality test shown in Table 5, the learning-independence difference scores obtained a significance value of 0.446, which was greater than 0.05. Therefore, the difference scores were normally distributed, indicating that the normality assumption for the paired-sample t-test was satisfied.

The results of the paired-sample t-test for learning independence are presented in Table 6.

Table 6 Results of Paired-Sample T-Test Learning Independence

Paired Samples Test								
Pair	Mean	Std. Deviation	Paired Differences			t	df	Sig. (2-tailed)
			Std. Error Mean	95% CI Lower	95% CI Upper			
Pretest - Posttest	-12.808	6.711	1.316	-15.518	-10.097	-9.731	25	.001

Based on the paired-sample t-test results in Table 6, the significance value was $p = 0.001$, which was lower than 0.05. This result indicates a statistically significant

difference between students' learning-independence scores before and after the implementation of Matching Puzzle learning media. The mean learning-independence score increased from 17.30 in the pretest to 30.11 in the posttest. These findings indicate that students demonstrated higher levels of learning independence following the implementation of the Matching Puzzle learning activities.

Learning independence refers to students' ability to actively regulate and take responsibility for their own learning process ([Laksana & Hadijah, 2019](#)). The increase in learning independence observed in this study may be related to the interactive and participatory nature of the Matching Puzzle activities. During the learning process, students were required to make decisions when identifying corresponding pictures and names, work collaboratively with group members, and complete the assigned matching tasks. These activities provided students with opportunities to participate actively rather than merely receive information from the teacher. From a constructivist perspective, active participation, interaction, and meaningful learning experiences can support students in constructing their own understanding and becoming more actively involved in the learning process ([Handoyo & Ani, 2025](#)). The findings are consistent with [Aulia et al. \(2019\)](#), who emphasized the importance of self-regulated learning in developing students' learning independence, and with [Ramlah et al. \(2022\)](#), who reported that interactive puzzle media can increase students' motivation and autonomous learning. The present findings complement these previous studies by applying a matching-based puzzle activity specifically to IPAS learning on the human respiratory system and by examining changes in learning independence alongside conceptual understanding. In practical terms, the findings suggest that teachers can use interactive matching activities as one alternative to create more participatory learning situations and provide students with opportunities to make decisions, collaborate, and take greater responsibility for completing learning tasks.

Study Limitations

This study has several limitations. First, the research involved only 26 fifth-grade students from a single elementary school, limiting the generalizability of the findings. Second, the study employed a one-group pretest-posttest design without a control group, making it difficult to attribute all observed improvements solely to the intervention. Third, the intervention was conducted over a relatively short period, so the

long-term effects of the Matching Puzzle learning media were not examined. Fourth, although different but equivalent question sets were used for the pretest and posttest to reduce recall and practice effects, some testing effects cannot be completely ruled out. Finally, learning independence was measured using a self-reported questionnaire, which may be influenced by response bias. Future studies are encouraged to involve larger and more diverse samples, include control groups, extend the intervention period, and combine questionnaire data with classroom observations or interviews to obtain more comprehensive findings.

Conclusion

Based on the results of this study, it can be concluded that students' conceptual understanding and learning independence showed significant improvements following the implementation of Matching Puzzle learning media in IPAS learning. The average conceptual understanding score increased from 34.61 in the pretest to 92.30 in the posttest, while the average learning independence score increased from 17.30 to 30.11. Furthermore, the Wilcoxon signed-rank test for conceptual understanding and the paired-samples t-test for learning independence showed statistically significant differences between the pretest and posttest scores ($p = 0.001$). These findings suggest that Matching Puzzle learning media can serve as an alternative instructional medium to support students' conceptual understanding and learning independence in IPAS learning.

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