



Crossword puzzles' effect on third-grade students' cognitive abilities in energy learning

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ABSTRACT

Cognitive ability plays a vital role in supporting student success at the elementary level. However, observations at SDN Kedaung Kaliangke 01 Pagi, West Jakarta, revealed that learning is still predominantly dominated by conventional media, making lessons less engaging and resulting in lower cognitive outcomes. This study aimed to examine the effect of Crossword Puzzle media on the cognitive abilities of third-grade students. A quasi-experimental method with a Nonequivalent Control Group Design was used. The sample consisted of 60 students divided into two groups: the experimental group received instruction using Crossword Puzzle media, while the control group received conventional teaching. The instrument was a multiple-choice test that had been validated for both validity and reliability. Data analysis included normality and homogeneity tests, followed by hypothesis testing using an Independent Sample t-test and effect size. The results showed a significant difference in cognitive abilities between the two groups. The experimental group demonstrated better conceptual understanding and more active engagement. These findings indicate that Crossword Puzzle media effectively enhances memory, concentration, analytical skills, and thinking ability. Therefore, this media is recommended as an innovative alternative to improve cognitive skills, especially in elementary science lessons on energy topics.

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ABSTRAK

Kemampuan kognitif memiliki peran krusial dalam menunjang keberhasilan belajar peserta didik di jenjang sekolah dasar. Namun, hasil observasi di SDN Kedaung Kaliangke 01 Pagi, Jakarta Barat, menunjukkan bahwa proses pembelajaran masih didominasi oleh media konvensional, sehingga cenderung kurang menarik dan berdampak pada rendahnya capaian kognitif peserta didik. Berdasarkan permasalahan tersebut, penelitian ini bertujuan untuk mengetahui pengaruh media Crossword Puzzle terhadap kemampuan kognitif peserta didik kelas III SD. Metode yang digunakan adalah kuasi eksperimen dengan desain Nonequivalent Control Group Design. Sampel terdiri atas 60 peserta didik yang dibagi ke dalam dua kelompok, yaitu kelompok eksperimen yang menggunakan media Crossword Puzzle dan kelompok kontrol yang mengikuti pembelajaran konvensional. Instrumen berupa tes pilihan ganda yang telah diuji validitas dan reliabilitasnya. Analisis data dilakukan melalui uji normalitas, homogenitas, serta uji hipotesis menggunakan Independent Sample t-Test dan effect size. Hasil penelitian menunjukkan perbedaan yang signifikan pada kemampuan kognitif antara kedua kelompok. Kelompok eksperimen menunjukkan pemahaman konsep yang lebih baik dan keterlibatan aktif dalam pembelajaran. Temuan ini membuktikan bahwa Crossword Puzzle efektif dalam meningkatkan daya ingat, konsentrasi, kemampuan analitis, dan berpikir peserta didik. Oleh sebab itu, media ini direkomendasikan sebagai alternatif inovatif untuk meningkatkan kemampuan kognitif peserta didik, khususnya dalam pembelajaran IPAS pada topik energi.

Kata Kunci: kemampuan kognitif; pembelajaran energi; sekolah dasar; teka-teki silang

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INTRODUCTION

In the current era, education plays an important role in almost all aspects of life. Education helps individuals optimally develop their potential across the cognitive, affective, and psychomotor domains (Fatoni, 2020). Education serves as a strategic means of shaping high-quality human resources that are adaptable to changing times. Society can strive to achieve intelligence by pursuing education, as the educational process itself involves various learning activities that enhance an individual's intellectual capacity (Lamuri & Laki, 2022). These learning activities not only serve as a process of knowledge transfer but also as a medium for shaping the character and critical thinking skills needed in daily life (Zarkasyi *et al.*, 2023).

At the elementary school level, learning objectives encompass three main domains: cognitive, affective, and psychomotor (Abdurohim *et al.*, 2024). Among these, the cognitive domain is crucial because it encompasses the ability to think, reason, and process information. This domain refers to Bloom's taxonomy, which serves as a reference in developing learning objectives (Hakim, 2020; Sihotang & Pohan, 2024). Mastery of the cognitive aspect supports students' learning, as the process trains them through stages of thinking, ranging from remembering to creating. This ability enables students to explore their surroundings and gain meaningful learning experiences (Purnamasari & Yusma, 2021). In this regard, one of the important subjects in elementary school is Natural and Social Sciences (IPAS), which students are required to study because it covers natural phenomena, living beings, and the social environment (Umami & Rimadoni, 2024).

IPAS learning in elementary schools must create an enjoyable learning atmosphere and stimulate students' enthusiasm so that they become interested in studying IPAS, especially on the topic of energy, which discusses the definition, forms, sources, and utilization of energy that can later build students' cognitive abilities (Prabowo & Wakhudin, 2024). One of the supports during learning is learning media. Learning will be enjoyable with the help of learning media (Kusuma & Bima, 2023). One learning media that can create playful and educational activities is the Crossword Puzzle. Crossword Puzzles can serve as a learning medium that generates students' interest in enjoyable learning while stimulating the brain to think, remember, and analyze, as they are kept busy searching for the appropriate answers (Amri, 2023).

Several previous studies have shown the effectiveness of Crossword Puzzles in improving students' cognitive abilities. Crossword puzzles have been shown to enhance students' problem-solving abilities in Chemistry, particularly in the periodic table of elements, by facilitating enjoyable, interactive learning and thereby encouraging higher cognitive engagement than conventional memorization methods (Umanah & Sunday, 2022). Furthermore, crossword-puzzle learning media significantly improve critical thinking skills among third-grade students, with post-test scores increasing from 72.50 in the control class to 84.50 in the experimental class, demonstrating their effectiveness in enhancing cognitive abilities (Mardhatillah & Anas, 2023). Other studies show that brain-based learning models using crossword puzzles significantly enhance students' understanding of scientific concepts and critical thinking skills, reinforcing the effectiveness of crossword puzzles as a learning medium to improve cognitive abilities in education (Wiantara *et al.*, 2020).

Based on observations and interviews in the third-grade science class at SDN Kedaung Kaliangke 01 Pagi, West Jakarta, there are still 11 out of 30 students who have low cognitive abilities as seen from their cognitive learning outcomes, including 8 students scoring 60 and 3 students scoring 70, which still do not meet the minimum competency criteria (KKM) of 75. The problem is caused by teachers still frequently using conventional media, namely printed books and blackboards, resulting in boring lessons and preventing students from optimally remembering and understanding the material studied, thereby contributing to the decline in students' cognitive abilities. Therefore, this study aims to integrate a student-centered teaching and learning process to improve cognitive abilities. This is certainly supported by

learning media, including the Crossword Puzzle. This medium is known to gradually enhance students' cognitive abilities, stimulate brain activity, improve memory and analysis, increase concentration, and engage students in learning activities in an enjoyable way.

Unlike previous studies that generally focus on specific subjects, such as chemistry, this study integrates the Crossword Puzzle as an innovative learning medium to improve students' cognitive abilities in the IPAS subject at the elementary school level, with the context of energy materials, which has not been widely researched. Based on the background described, this study aims to determine the effect of the Crossword Puzzle medium on the cognitive abilities of third-grade elementary school students in the Social Sciences, with the topic of energy. Engaging and interactive learning media, such as Crossword Puzzles, are believed to increase interest in learning and facilitate understanding of basic energy concepts in a more enjoyable and meaningful way. This study also intends to address the need for learning innovations that are not only theoretical but also capable of activating students' cognitive roles in the learning process. The results of this study are expected to contribute to the development of effective learning strategies, particularly for Social Sciences instruction at the elementary school level.

LITERATURE REVIEW

Cognitive Ability

Cognitive ability is an important aspect of students' intellectual development. Bloom defines cognitive ability as the capacity related to intellectual aspects, including thinking and reasoning, and encompasses mental activities or brain work (Hakim, 2020). In line with this view, cognitive ability is understood as encompassing mental activities such as perception, reasoning, memory, and information processing (Nisa *et al.*, 2023). Cognitive ability is defined as "thinking," encompassing activities related to perception, thought processes, memory, and information processing. This term encompasses all psychological processes related to how a person learns, attends, observes, imagines, estimates, evaluates, and solves problems (Marinda, 2020). Furthermore, cognitive ability can be viewed as an indicator of cognitive development, as it enables individuals to reason logically, think systematically, and solve problems sequentially (Wayudi *et al.*, 2020). Therefore, cognitive ability provides the foundation for learners to develop logical thinking and understand concepts relevant to everyday life. This domain emphasizes the development of intellectual skills and critical thinking.

Indicators of Cognitive Ability

The cognitive domain refers to Bloom's Taxonomy, which classifies thinking processes into six levels, ranging from lower-order (Lower-Order Thinking Skills, LOTS) to higher-order (Higher-Order Thinking Skills, HOTS). Mastery of higher-level thinking skills requires a gradual process, starting with the mastery of basic cognitive levels as the initial foundation (Risqi *et al.*, 2025). Instructional objectives at the HOTS level cannot be achieved until learners have mastered the LOTS level. Indicators of cognitive ability according to Bloom's Taxonomy include six categories: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6). Remembering (C1) refers to the learner's ability to recall terms or information that has been learned. Understanding (C2) indicates the ability to comprehend the meaning of a question or statement. Applying (C3) involves the ability to implement information in the appropriate context. Analyzing (C4) involves decomposing relationships among information components. Evaluating (C5) entails assessing or making decisions based on specific criteria, and creating (C6) entails generating new ideas or innovative solutions (Nafiati, 2021).

Bloom emphasizes that developing all cognitive levels in the learning process is essential to produce quality education (Nurhakim *et al.*, 2025). Cognitive abilities help learners understand concepts, reason logically, and solve various problems systematically. Additionally, cognitive ability functions as working memory that can store information in the short or long term, enabling learners to access and reuse that information when needed (Ningrum & Muhid, 2024). Learners' cognitive abilities range from level C1 to C6, with each level corresponding to specific operational verbs (Azizah *et al.*, 2024). Therefore, cognitive ability is a crucial aspect that must be developed to enable students to solve problems effectively, in accordance with the demands of elementary school learning.

Factors Influencing Cognitive Ability

According to Piaget's theory, the development of cognitive ability is influenced by two main factors: internal factors originating within the individual and external factors arising from the surrounding environment (Izzuddin, 2021; Marinda, 2020; Ramadhina, 2024). The explanation of these two factors can be described as follows:

1. Internal Factors: Factors originating from within a person, internal factors include: 1) Heredity factors are believed to determine how a child's cognitive development will proceed; 2) Maturity factors, the capability in physical or psychological conditions to perform their respective roles; 3) Interest and talent factors as support to develop cognitive abilities into the best version of the individual.
2. External Factors: Factors originating from outside, external factors include: 1) Environmental factors, including social environment and knowledge acquired, which will affect the state of the child's cognitive development; 2) Deliberate formation factors can be pursued through the education process, while accidental formation is obtained from the surrounding environment, which will impact the child's cognition; 3) Freedom factors relate to human freedom in thinking and acting, this is related to parenting, which will impact the child's cognitive development.

This confirms that these factors work together to shape the child's overall cognitive development.

Media Crossword Puzzle

A crossword puzzle is a game media used to fill empty boxes with letters to form words as answers to given questions (Khairunnufus *et al.*, 2024). This medium is also understood as a method for reviewing previously learned material, in which students fill in the blanks horizontally and vertically (Handayani & Sofyan, 2022). Crossword puzzles are considered capable of creating a fun, active, and meaningful learning activity while maintaining an educational character. The use of this medium can increase students' interest in the material, foster curiosity, and help them retain the knowledge they have learned more easily (Tejeswini *et al.*, 2024).

METHODS

This study uses a quantitative approach with a Quasi-Experimental Design and applies a Nonequivalent Control Group Design. This design involves two groups: the experimental group (class III-B), which receives treatment using Crossword Puzzle media in learning, and the control group (class III-A), which does not receive treatment and uses conventional learning methods to assess the effect of the intervention on specific variables. In this study, students' cognitive abilities were assessed using a written multiple-choice test developed based on Bloom's taxonomy, covering levels from basic to intermediate. The research site at SDN Kedaung Kaliangkke 01 Pagi was selected based on initial observations indicating

low memory and cognitive abilities among students, which may be attributable to the use of conventional learning media.

This study set the research population at 60 third-grade students. The entire population was used as the sample with a saturated sampling technique. The sample comprised two classes: class III-B (experimental group) and class III-A (control group), each with 30 students. Furthermore, teachers at the school tended to rely on lecture methods and blackboards, without innovative and engaging learning media, resulting in less effective learning and lower cognitive learning outcomes among students. This study was conducted over three meetings using a prepared teaching module. The treatment involved using a crossword puzzle as a media-rich activity in the experimental class during the energy materials lessons, whereas the control class continued with regular instruction without the media.

The measurement of students' cognitive abilities was conducted using an instrument comprising 30 multiple-choice questions, developed based on indicators of energy materials. Before use, the instrument's validity and reliability were tested. Validity testing was performed using the Pearson Product-Moment formula, with the criteria being valid if the calculated r value $>$ the table r value. Reliability testing was conducted using the KR-20 and Cronbach's Alpha formulas, with the criteria being reliable if the alpha value $>$ 0.60. Scoring was done by giving a score of one for each correct answer and zero for incorrect answers. The obtained data were analyzed quantitatively using SPSS software version 25. Data testing included normality testing using the Kolmogorov–Smirnov test (considered normal if $p > 0.05$), homogeneity testing using Levene's Test (homogeneous if $p > 0.05$), and hypothesis testing using the Independent Sample t-Test with significance criteria $<$ 0.05 or calculated $t >$ table t . Effectiveness testing using Cohen's d effect size was conducted to determine the magnitude of the effect, with a d value ≥ 0.8 interpreted as a high category.

RESULTS AND DISCUSSION

This study aims to determine the effect of the Crossword Puzzle media on the cognitive abilities of third-grade elementary school students regarding energy material. This section presents the results of the data analysis systematically, covering the validity and reliability of the instruments, descriptive statistics for the pretest and posttest, tests of data normality and homogeneity, and hypothesis testing using the Independent-Samples T-Test and Effect Size.

Validity and Reliability Test

The study was conducted in the third grade at SDN Kedaung Kaliangke 01, in the Morning session, involving two groups: the experimental class (3-B) using the Crossword Puzzle medium and the control class (3-A) learning conventionally, each consisting of 30 students. Before use, the pretest and posttest instruments were tested for validity and reliability. Validity was tested using Pearson Product-Moment correlation with a table r of 0.361 ($n = 30$, $df = 28$, $\alpha = 0.05$). Out of 30 items, 20 were declared valid because they had a calculated $r >$ table r , and the rest were eliminated. Reliability was assessed using Cronbach's alpha, yielding 0.750, indicating acceptable reliability ($\alpha > 0.60$). Thus, the 20 valid items were used as the main instruments in the pretest and posttest for both groups.

Descriptive Statistics of the Experimental Class

The instruments deemed valid and reliable were then used to measure pretest and posttest outcomes in both groups. The data collected from the experimental class are presented in descriptive statistics to

provide a general overview of the distribution of students' cognitive abilities before and after the treatment. The following is the frequency distribution of pretest and posttest scores in the experimental class.

Table 1. Frequency Distribution of Pretest and Posttest Scores in the Experimental Class

| Interval Nilai | Pretest | | Posttest | |
|-------------------|-----------|----------------|-----------|----------------|
| | Frekuensi | Persentase (%) | Frekuensi | Persentase (%) |
| 35–43 | 6 | 20% | – | – |
| 44–52 | 4 | 13% | – | – |
| 53–61 | 6 | 20% | – | – |
| 62–70 | 7 | 23% | – | – |
| 71–79 | 5 | 17% | – | – |
| 80–89 | 2 | 7% | – | – |
| 50–58 | – | – | 1 | 3% |
| 59–67 | – | – | 5 | 17% |
| 68–76 | – | – | 6 | 20% |
| 77–85 | – | – | 8 | 27% |
| 86–94 | – | – | 7 | 23% |
| 95–100 | – | – | 3 | 10% |
| Total | 30 | 100% | 30 | 100% |

Source: Research 2025

Table 1 presents the frequency distribution of pretest and posttest scores of students in the experimental class who participated in learning using the Crossword Puzzle media on the topic of energy. Before the treatment (pretest), most students were in the low- to moderate-score categories. A total of 6 students (20%) were in the score interval 35–43, 4 students (13%) in the interval 44–52, and 6 students (20%) in the interval 53–61. The most populated score interval was 62–70, with 7 students (23%), while 5 students (17%) were in the 71–79 interval. Only 2 students (7%) met the 80–89 interval. After the treatment was given through the Crossword Puzzle media (posttest), the score distribution shifted significantly higher. Only 1 student (3%) was in the interval 50–58, 5 students (17%) were in the interval 59–67, and 6 students (20%) were in the interval 68–76. The highest concentration of scores was in the interval 77–85 (8 students, 27%), followed by 86–94 (7, 23%), and 3 students (10%) achieved the highest scores in 95–100. These findings indicate an improvement in students' cognitive abilities in the experimental class following the implementation of the Crossword Puzzle media in the learning process. The shift in score distribution toward higher categories indicates that this medium affects cognitive abilities related to energy materials among elementary school students.

Descriptive Statistics of the Control Class

To provide a comprehensive comparison, an analysis was also conducted of the control group that did not receive the Crossword Puzzle media treatment. The following data present the frequency distribution of pretest and posttest scores in the control class to assess the extent of gains in cognitive abilities, for comparison with the experimental class.

Table 2. Frequency Distribution of Pretest and Posttest Scores in the Control Class

| Score Interval | Pretest | | Posttest | |
|-------------------|-----------|----------------|-----------|----------------|
| | Frequency | Percentage (%) | Frequency | Percentage (%) |
| 30–37 | 7 | 23% | – | – |
| 38–45 | 7 | 23% | – | – |
| 46–53 | 1 | 3% | – | – |
| 54–61 | 9 | 30% | – | – |
| 62–69 | 4 | 13% | – | – |

| Score Interval | Pretest | | Posttest | |
|----------------|-----------|----------------|-----------|----------------|
| | Frequency | Percentage (%) | Frequency | Percentage (%) |
| 70–77 | 2 | 7% | – | – |
| 45–51 | – | – | 6 | 20% |
| 52–58 | – | – | 5 | 17% |
| 59–65 | – | – | 9 | 30% |
| 66–72 | – | – | 3 | 10% |
| 73–79 | – | – | 4 | 13% |
| 80–86 | – | – | 3 | 10% |
| Total | 30 | 100% | 30 | 100% |

Source: Research 2025

Table 2 shows the frequency distribution of pretest and posttest scores of students in the control class who participated in learning without the use of the Crossword Puzzle media in the energy material. Based on the pretest results, the majority of students were in the low score category. Seven students (23%) were in the score interval of 30–37, and another seven students (23%) were in the interval of 38–45. Furthermore, there was 1 student (3%) who scored in the interval of 48–53, 9 students (30%) in the interval of 54–61, 4 students (13%) in the interval of 62–69, and 2 students (7%) in the interval of 70–77. No students scored above 77 during the pretest. Following conventional instruction, scores increased, although the change was not statistically significant compared with the experimental class. At the posttest, 6 students (20%) scored within the 45–51 range, and 5 students (17%) within the 52–58 range. The largest number of students, 9 (30%), fell within the 59–65 range. Next, 3 students (10%) were in the 66–72 range, followed by 4 students (13%) in the 73–79 range, and the highest scores were obtained by 3 students (10%) in the 80–86 range. Overall, no students scored above 86 after the learning session. These findings indicate an improvement in the cognitive abilities of students in the control class, as evidenced by a shift in the score distribution toward higher intervals. However, this improvement was not statistically significant and was concentrated in the lower score categories. This suggests that learning without interactive media, such as a Crossword Puzzle, is less effective at promoting overall cognitive ability among students.

Requirement Analysis Testing

Data were analyzed to verify that the assumptions underlying hypothesis testing were met. This test aims to provide a clear and systematic overview of the data characteristics, enabling accurate analysis and understanding by both the researcher and other interested parties. This study involved two groups, namely the experimental class (class 3-B) and the control class (class 3-A). Both classes share similar characteristics with respect to initial ability and learning environment conditions, enabling parallel analysis. The main difference between the two groups lies in the treatment given. The experimental class received instruction using a crossword puzzle, whereas the control class received conventional instruction without the media. Before further analysis is conducted, prerequisite tests need to be performed to ensure that the data meet the assumptions of normality and homogeneity. The normality test assesses whether the data are normally distributed, whereas the homogeneity of variance test assesses whether the variances of the data in both groups are homogeneous. These prerequisite tests are explained as follows.

Normality Test

The normality test in this study was conducted using the Kolmogorov-Smirnov method. The decision criterion is that the data are said to be normally distributed if the significance value (Sig.) is greater than 0,05.

Table 3. Kolmogorov-Smirnov Normality Test

| Cognitive Ability Results | Kelas | Statistic | df | Sig. |
|---------------------------|---------------------|-----------|----|------|
| | Pretest Experiment | .146 | 30 | .100 |
| | Posttest Experiment | .133 | 30 | .184 |
| | Pretest Control | .138 | 30 | .151 |
| | Posttest Control | .133 | 30 | .189 |

Source: Research 2025

Based on the results of the Kolmogorov-Smirnov test presented in **Table 3**, the significance values (Sig.) for each group are as follows: pretest of the experimental class is 0.100, posttest of the experimental class is 0.184, pretest of the control class is 0.151, and posttest of the control class is 0.189. All these p-values exceed 0.05. Therefore, it can be concluded that the pretest and posttest data in both groups are normally distributed. This indicates that the data meet one of the basic assumptions for parametric analysis, so hypothesis testing can be conducted using parametric statistical tests, such as the t-test and effect-size tests.

Homogeneity Test

After the data are declared normally distributed, the next step is to test the homogeneity of variances to determine whether the variances between groups (experimental and control) are equal. The homogeneity test in this study was conducted using Levene's Test with a significance level of 0.05.

The decision criteria are as follows:

1. If the significance value > 0.05, the variances between groups are considered homogeneous.
2. If the significance value < 0.05, the variances are not homogeneous.

The results of the homogeneity test are presented in **Table 4** below.

Table 4. Homogeneity Test

| Cognitive Ability | Levene Statistic | | df1 | df2 | Sig. |
|-------------------|--------------------------------------|------|-----|--------|------|
| | Based on Mean | .729 | 1 | 58 | .397 |
| | Based on Median | .787 | 1 | 58 | .379 |
| | Based on Median and with adjusted df | .787 | 1 | 57.579 | .379 |
| | Based on the trimmed mean | .741 | 1 | 58 | .393 |

Source: Research 2025

Based on the results of the variance homogeneity analysis using Levene's Test in **Table 4**, the significance values obtained were 0.397 for calculations based on the mean, 0.379 based on the median, 0.379 based on the median with adjusted df, and 0.393 based on the trimmed mean. All these significance values are above the significance threshold of 0.05, indicating that there is no significant difference in variance

between the experimental group and the control group. Thus, it can be concluded that the cognitive ability data for the students in both groups have homogeneous variances (Levene's Test, $p > 0.05$), thereby satisfying one of the basic assumptions for conducting further parametric statistical tests.

Research Hypothesis Testing

The hypothesis test in this study was conducted using the Independent Sample t-Test technique assisted by SPSS version 25 software. This test was used to compare the average posttest scores between two groups: the experimental group that received treatment using the Crossword Puzzle medium and the control group that did not receive this treatment. The decision criteria for this test are as follows.

H_0 : There is no significant effect of using Crossword Puzzle media on the cognitive ability of students in the Energy material for Grade III at SD Negeri Kedaung Kaliangke 01 Pagi.

H_a : There is a significant effect of using the Crossword Puzzle media on the cognitive abilities of students in the Energy material for Grade III at SD Negeri Kedaung Kaliangke 01 Pagi.

The description of the t-test results is presented in **Table 5** below.

Table 5. Independent Sample t-Test

| | Levene's Test For Equality of Variance | | t-Test for Equality of Means | | |
|----------------------------------|--|------|------------------------------|--------|----------------|
| | F | Sig. | t | df | Sig. (2tailed) |
| Cognitive Ability Results | | | | | |
| Equal Variances assumed | .729 | .397 | 5.570 | 58 | .000 |
| Equal variances are not assumed. | | | 5.570 | 56.586 | .000 |

Source: Research 2025

The results of the Independent Sample t-Test shown in **Table 5** indicate that the significance value (Sig. 2-tailed) is 0.000, which is less than the significance level of 0.05. Furthermore, the calculated t-value is 5.570, exceeding the table t-value at $df = 58$, which is 2.002. Based on these results, the decision is to reject H_0 and accept H_a , indicating a significant difference between the experimental and control groups in students' cognitive abilities following the treatment. This result is supported by descriptive statistics showing that the experimental group's average posttest score is 80.50 (SD = 13.27), whereas the control group's average is 62.83 (SD = 11.27). The higher average score in the experimental group indicates that the use of crossword puzzles in learning has a positive effect on students' cognitive abilities. Thus, it can be concluded that the Crossword Puzzle medium has a significant effect on students' cognitive abilities regarding energy materials in Grade III elementary school.

Effect Size Test

This test aims to determine the extent to which the use of the Crossword Puzzle medium influences the cognitive abilities of 3rd-grade students in the energy material.

Table 6. Independent Samples Effect Sizes

| | | Standardizer ^a | Point Estimate | 95% Confidence Interval | |
|-------|--------------------|---------------------------|----------------|-------------------------|-------|
| | | | | Lower | Upper |
| Score | Cohen's d | 12.284 | 1.438 | .864 | 2.003 |
| | Hedges' correction | 12.446 | 1.420 | .853 | 1.977 |
| | Glass's delta | 11.271 | 1.567 | .913 | 2.205 |

Source: Research 2025

Based on the results of the Independent Samples Effect Size test (see **Table 6**), it is known that the Cohen's d value is 1.438 with a 95% confidence interval ranging from 0.864 to 2.003. The Hedges' correction value is 1.420, and Glass's delta is 1.567. These three values are above 0.8. Referring to the interpretation of effect size, an effect size value ≥ 0.8 is categorized as high, a value between 0.5 and < 0.8 is categorized as moderate, and a value between 0.2 and < 0.5 is categorized as low. Therefore, it can be concluded that the influence of the Crossword Puzzle media on improving students' cognitive abilities falls into the high category. This indicates that the intervention not only produced a statistically significant difference but also had a substantial practical impact on students' cognitive abilities in learning about energy materials.

Discussion

The results of this study show that the use of Crossword Puzzle media is proven to be more effective compared to conventional learning in improving the cognitive abilities of 3rd-grade elementary school students in energy material. This is demonstrated by the results of the t-test, which show a significant difference between the posttest scores of the experimental class ($M = 80.50$) and the control class ($M = 62.83$), with a significance value of 0.000 (< 0.05). Furthermore, the effect size of 1.438 indicates that the effect is considered substantial. Crossword puzzles significantly and substantially improve students' cognitive abilities. This finding aligns with previous research showing that Crossword Puzzle media can enhance students' thinking skills. This media is considered effective in stimulating brain activity, improving information retention, and facilitating concept understanding (Torres *et al.*, 2022).

A repetitive learning approach through interactive media can strengthen students' memory and activate higher-order thinking processes (Ulfah & Arifudin, 2023). Other studies also show that the use of a Crossword Puzzle in IPAS learning positively impacts the cognitive learning outcomes of elementary school students (Nanda & Murwitaningsih, 2025). Several other studies also confirm the effectiveness of the Crossword Puzzle in improving students' cognitive abilities. Crossword puzzles have been shown to enhance students' understanding and retention of the periodic table by facilitating enjoyable, interactive learning, thereby encouraging greater cognitive engagement than conventional memorization methods. This strategy allows students to participate actively, enhances retention, and strengthens conceptual understanding by having students complete word clues relevant to the material. Research shows that students taught using the crossword puzzle strategy achieve significantly higher learning outcomes than those taught with flashcards (Umanah & Sunday, 2022).

The use of crossword puzzle learning media significantly improves critical thinking skills among third-grade students, with post-test scores increasing from 72.50 in the control class to 84.50 in the experimental class, demonstrating its effectiveness in enhancing cognitive abilities (Mardhatillah & Anas, 2023). Other studies indicate that brain-based learning models using crossword puzzles significantly improve students' understanding of science concepts and critical thinking skills, reinforcing the effectiveness of crossword puzzles as a learning medium in boosting cognitive abilities in education (Wiantara *et al.*, 2020). The effectiveness of the Crossword Puzzle media in enhancing cognitive abilities can be explained through

Bloom's Taxonomy approach, which classifies thinking processes into six levels: remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6) (Nafiati, 2021).

The Crossword Puzzle encourages students to progress from basic to complex levels by presenting questions that require concept recognition, understanding of clues, and accurate completion of answers. This aligns with Bloom's view, which emphasizes the importance of developing all cognitive levels in the learning process to achieve quality education (Nurhakim *et al.*, 2025). The Crossword Puzzle encourages students to progress from basic to complex levels by presenting questions that require concept recognition, understanding of clues, and accurate completion of answers. This aligns with Bloom's view, which emphasizes the importance of developing all cognitive levels in the learning process to achieve quality education (Marinda, 2020; Ramadhina, 2024). In this context, the Crossword Puzzle medium serves as an external stimulus that supports the formation of students' cognitive structures, particularly due to its enjoyable, challenging nature and its activation of logical thinking processes. This process enables students to solve problems, connect concepts, and develop systematic thinking strategies (Wayudi *et al.*, 2020).

This study shows that the use of crossword puzzles has a positive effect on the cognitive abilities of 3rd-grade elementary school students in IPAS learning. However, several limitations need to be considered. First, this study was conducted at a single school and involved a small sample of 60 students; therefore, the results cannot yet be generalized to other schools with different conditions. Second, the instrument used to measure cognitive ability, in the form of multiple-choice questions, tends to assess thinking skills at a lower level, or Lower Order Thinking Skills (LOTS), such as remembering, understanding, and applying. This indicates that the instrument does not fully assess higher-order thinking skills (C4–C6) in Bloom's Taxonomy. Third, the quantitative approach employed in this study cannot fully capture the cognitive processes students experience during learning activities.

Although the Crossword Puzzle media is designed to gradually train students' thinking skills, starting from recalling (C1) terms or information from the material studied, then understanding (C2) the meaning of the question clues, applying (C3) in the form of correct answers, analyzing (C4) the relationships between questions and answers, evaluating (C5) answer choices, to creating (C6) the complete word, this media has not yet fully explored higher-order thinking skills comprehensively. This is likely because the students in this study were third-grade students, who are still in the early stages of logical thinking development (Izzuddin, 2021). Therefore, the results indicate greater improvement in basic-to-intermediate thinking skills.

Based on these findings, this study has several important implications. One of them is the need to use innovative learning media appropriate to students' developmental stages. Crossword puzzles can be an effective medium for creating enjoyable learning experiences, fostering interest, and helping students better understand the material. Teachers are expected to design learning activities that not only convey information but also encourage students to think critically and engage in the learning process. Furthermore, in the context of science learning in elementary schools, a crossword puzzle can be an effective medium for fostering a fun and active learning environment. Teachers are expected to design learning activities that are not only informative but also systematically develop students' cognitive capacities (Jumrawati & Lina, 2025). These findings also align with student-centered learning approaches and challenge-based contextual learning, which are the current directions of educational policy.

CONCLUSION

Based on the research results, it can be concluded that the use of the Crossword Puzzle medium has a positive and significant effect on the cognitive abilities of third-grade elementary school students in the energy material. This is demonstrated by a significant difference in posttest scores between the

experimental and control groups, as well as a large effect size, indicating a strong practical impact of the learning intervention. The use of crossword puzzles can foster a more active, enjoyable learning environment and encourage students' cognitive engagement with basic science concepts. This medium not only improves learning outcomes but also strengthens memory, concentration, analytical thinking, and student engagement. These findings address the initial problem of low cognitive achievement due to the use of less engaging conventional media. Furthermore, these findings demonstrate that integrating innovative learning media, such as Crossword Puzzles, can enhance the quality of cognitive learning in elementary schools. Therefore, this media is recommended as an effective alternative learning strategy to support the achievement of learning objectives, especially in science subjects. Further research is recommended to implement the Crossword Puzzle media in different subject contexts and educational levels to test the generalizability of the findings. A larger sample size should be considered to improve the representativeness of the research results. Additionally, integrating this media with other learning approaches, such as collaborative or project-based learning, can enrich the learning dynamics and enhance the effectiveness of the intervention. A mixed-methods approach is also recommended to explore students' thinking processes during learning activities more comprehensively. On the other hand, the development of evaluation instruments that accommodate indicators at higher-order thinking levels in Bloom's Taxonomy (C4–C6) is necessary to ensure that learning assessments more comprehensively reflect cognitive abilities.

AUTHOR'S NOTE

The researchers have confirmed that there is no conflict of interest affecting the publication of this article and guarantee that all data and content of this article are free from plagiarism.

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