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DEVELOPMENT *CROSS NUMBER PUZZLE* TO FACILITATE THE COGNITIVE DIMENSIONS OF BASIC ARITHMETIC MATERIAL FOR ELEMENTARY SCHOOL STUDENTS

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ABSTRACT

Basic arithmetic is an important aspect of mathematics learning at elementary school level. However, students often have difficulty understanding basic arithmetic concepts. Using innovative and fun learning methods can help students understand basic arithmetic material better. The aim to be achieved in this research is to develop media *cross number puzzle* to facilitate the cognitive dimension of basic arithmetic material and understand the impact of use *cross number puzzle* on the critical thinking abilities of elementary school students. This type of research is research and development (*research and development*) using the ADDIE model. The data collection techniques used were interviews, observations and questionnaires. The media in this development research is subject to assessment in the form of media expert validation, material experts, teacher response questionnaires, and student response questionnaires in order to strengthen media validation. This development uses 5 cognitive dimensions and was tested on 22 students. The results of the development are in the form of media *cross number puzzle* to facilitate the cognitive dimension of basic arithmetic material. Impact of media use *cross number puzzle* can be seen by an increase in results *post-test* which has been tested using the T-test. Based on the results of research that has been carried out, suggestions that can be made are that it can be developed further because it is very suitable for use using learning media *cross number puzzle* because it makes it easier for students to understand basic arithmetic material and requires further media development. This aims to produce higher quality and innovative media.
Keywords: *Cognitive Dimension, Cross Number Puzzle, Basic Arithmetic*

INTRODUCTION

Rostina Sundayana (2014: 2) said that mathematics is one of the materials from a collection of learning materials which has an important role in the world of education which has an influence on the development of science and technology. Mathematics education at the elementary school level has an important role in forming a strong foundation of knowledge and understanding. Kosasih (2014: 11) said that learning can be interpreted as a way that consciously involves the insight possessed by the teacher so that students can achieve learning goals.

Learning mathematics cannot be separated from counting activities. Amreta, Rofi'ah, & Markhamah (2023) said that Mathematics itself is a part of education that can train students to think critically and have the ability to think logically, analytically, systematically, critically and creatively as well as the ability to work together. Mathematics is a subject that is taught from an early age as a preparation for moving to a higher level of education. Sari, Ervina, M Yusuf (2020:184) Mathematics is a subject that plays an important role in education and is considered difficult learning. According to Robert Reys (1998:2) People often equate mathematics and arithmetic, even though arithmetic focuses on numbers or numbers, while mathematics is broader than just simple calculations in arithmetic. In the opinion of Irawan & Daeka (2015: 7) that learning mathematics is more directed towards reasoning and logic, not just learning to count or learning numbers.

According to Hermita (2021), elementary school level students are expected to have indicators of critical thinking skills, because during the learning process students develop ideas for the problems they encounter. According to Lambertus (2019) Critical thinking is an ability possessed by all individuals, which can be measured, trained and developed, apart from that it has a mathematical relationship with critical thinking according to. Critical thinking skills also have indicators proposed by (Facione, 2020), among others *Interpretation, analysis, evaluation, inference, explanation,* as well as *self regulation.* Therefore, teachers need to train students to improve their critical thinking skills by using learning strategies that stimulate students to think critically. Pranata, A. H., Saputro, B. A., & Handayani, A. (2023) with the ADDIE development model shows that the problem-based learning model teaching module developed is proven to be valid, practical, and effective so it is very suitable for use in mathematics learning in elementary schools to improve skills. students' critical thinking.

Basic arithmetic is an important aspect of mathematics learning at elementary school level. However, students often have difficulty understanding basic arithmetic concepts. Therefore, the use of innovative and fun learning methods that can help facilitate students' cognitive dimensions in understanding basic arithmetic material better is games. One method that can be used is use *puzzle* mathematics. Development *cross number puzzle* as a learning aid. The development of good learning media can help students increase understanding, so that the teaching and learning process becomes easy and interesting so that it can help students achieve the specified basic competencies. Veronica, I., Subekti, E. E., & Tsalatsa, A. N. (2019) Low student interest in learning due to lack of media use results in students' lack of understanding. This research uses research methodology *Research and Development (R&D)* and the ADDIE development model. The results of this research are mThe learning media can be accepted by students as proven by student enthusiasm and student responses.

At this stage, the development of the cognitive dimension is very important because it is related to students' understanding, reasoning and critical thinking abilities. One way to facilitate the development of students' cognitive dimensions is through the use of various types of games and challenging learning activities. Planning educational game "*Cross Number Puzzle*" which is intended as a medium for learning basic arithmetic which aims to make students more interested in their interests and help students become more familiar with the lessons of basic arithmetic calculation operations.

Game development *Cross Number Puzzle* useful for improving the cognitive dimensions of students in elementary schools. With development *Cross Number Puzzle* accordingly, it is hoped that children can learn while having fun and effectively improve their ability to think critically while studying mathematics. *Cross number puzzle* can be an effective tool in learning basic arithmetic. This game engages students in solving simple math problems in a fun way. This can increase students' motivation in studying mathematics and encourage critical thinking and problem solving. It could be said that mathematics is the foundation of mathematics and a student's arithmetic ability is an ability that must be mastered by elementary school students.

Educators play an important role in helping students develop cognitive dimensions by designing learning experiences that are challenging, relevant, and support their cognitive development. The cognitive dimension consists of three domains, namely knowledge (*knowing*), application (*applying*) and reasoning (*reasoning*). By understanding and paying attention to these three components, students can gain a deeper understanding and stronger thinking skills, so that the teaching and learning process runs smoothly.

Based on display Therefore, the researcher conducted research with the title "Development *Cross Number Puzzle* to Facilitate the Cognitive Dimensions of Basic

Arithmetic Material for Elementary School Students". This research focused in basic arithmetic calculation operations including addition, subtraction, multiplication and division.

THEORETICAL STUDY

Mathematics education at the elementary school level has an important role in forming a strong foundation of knowledge and understanding. The use of supportive learning media can help students solve problems by thinking critically. According to (Lambertus, 2019) critical thinking is an ability possessed by all individuals, which can be measured, trained and developed, besides that it has a relationship between mathematics and critical thinking. Critical thinking skills also have indicators proposed by (Facione, 2020), among others *Interpretation, analysis, evaluation, inference, explanation,* as well as *self regulation.* The benefits of critical thinking skills are considered important to equip students to face challenges and make the learning process more active. Based on the results of initial research in class V, the obstacles experienced in teaching and learning activities were in class management where students were bored with monotonous learning. Teachers' teaching and learning activities still use conventional learning methods such as the lecture method and the use of media or other learning tools. Teachers are still less creative and innovative. These learning activities tend to be monotonous, resulting in students getting bored quickly. In the teaching and learning process, teachers only use the lecture method in learning, so to overcome this problem, supporting methods and media are needed to provide students with an understanding of basic arithmetic material.

PREVIOUS RESEARCH

Research conducted by Naulita Permatasari Pandjaitan (2019), entitled Effectiveness of Media Use *Cross Number Puzzle* In Learning Arithmetic for Elementary School Students. The results of this research show that: (1) media use *Cross Number Puzzle* proven to be effective in helping students reduce counting errors experienced by students, (2) The average pre-test score is 27.78 and post-test 71.67. The result of the average value *post-test* tall one prove that students experience positive changes after using media *Cross Number Puzzle*. In this research, there are similarities and differences between what the researcher conducted and the research conducted by Naulita (2019), namely that they both use media. *Cross number puzzle* The difference is that the research methods used are different for researchers to develop media.

Research conducted by Ria Octa Vioni (2023) with the research title "Development of Learning Media *Game Integer* on Material on Basic Arithmetic Operations of Integers". The results of this research show that based on the average value of the validation test results, a value of 87.33 was obtained in the very good category for use without revision. Practical media based on the practicality test obtained an average value of 88.61.

The results of research conducted by Tia Monica et al (2022) with the research title "Development of Interactive Multimedia Based on Google Slides in Improving Students' Critical Thinking Abilities on Area and Plane Material for Class IV Elementary Schools". In this research, the ADDIE method was used. The results of the material expert validation test produced a percentage of 92% with a very good category and the media expert lecturer's validation results showed that it was very good with a percentage of 95%. Student responses show that the average validity is 4.5 with a percentage of 91%. The conclusion of this research explains that interactive multimedia based on Google Slides can improve students' critical thinking skills regarding flat shapes in class IV elementary school. The similarity between the research above and the researcher's thesis is that they both use the ADDIE development model.

RESEARCH METHODS

The type of research is development research or *Research and Development* (R&D) using the ADDIE model development method (*Analysis, Design, Development, Implementation, Evaluation*). The research was conducted at Purworejo 02 Pati State Elementary School. Data collection techniques can be used to analyze observation results to determine the needs of this research:

1) **Observation**

   At this stage the researcher made observations at SD Purworejo 02. Observation is one of the data collection methods used by researchers in mathematics teaching media development activities. The observation method that researchers use uses unstructured observation techniques. This observation method is used at the preliminary research and initial information gathering stages.

2) **Interview**

   Interviews are a way of collecting data to find existing problems regarding a condition through respondents (Sugiyono, 2015). In development research *cross number puzzle* This method uses interviews conducted with teachers. This interview method was used at the preliminary research and initial information gathering stage, namely an interview with the fifth grade teacher at SD Purworejo 02 Pati, which is in the attachment.

3) **Questionnaire (Questionnaire)**

   Sugiyono (2016:142) questionnaire is a data collection topic that is carried out by giving written questions to respondents to answer questions. In this study, researchers used instruments in the form of questionnaires to collect data, including a questionnaire on class V teacher responses to media development. *Cross number puzzle* counting operations and student response questionnaires. At this stage of the research, the researcher provided an assessment questionnaire for media experts, material experts, and a response questionnaire for class V teachers at SD Purworejo 02 Pati.

   Media development research *cross number puzzle* This method uses questionnaire instruments including material expert assessment questionnaires, media expert assessment questionnaires, student response questionnaires, and class V teacher response questionnaires. According to Sugiyono (2015: 199) a questionnaire is a data collection technique that is carried out by giving a set of questions or written questions to respondent to answer.

Data analysis techniques used in design and development research use qualitative and quantitative data. Qualitative data was obtained through observation and interviews during needs analysis. In this research, qualitative data was used *scale likert* to measure the attitudes, opinions and perceptions of a person or group of people about social phenomena (Sugiyono, 2015:134). Success indicators with quantitative data can be obtained from the eligibility criteria with the average score obtained as follows:

Table 1. Media appropriateness interpretation criteria

EVALUATION	Qualitative Criteria
81% – 100%	Very worth using
61% – 80%	Worth it
41% – 60%	Enough
21% – 40%	Not enough
0% – 21%	Very less

Source: Research and Development Agency, Ministry of Home Affairs which has been refined by researchers and supervisors.

RESULTS AND DISCUSSION

This research was carried out at SD Negeri Purworejo 02 which is located on Jl. Pati-Juwana Km. 8 Ds. Purworejo, Pati Regency. In this research, researchers used *pretest* and *post* test as quantitative data to support research results. Researchers conducted a t-test. In this research, data collection was carried out in 3 ways, namely interviews, observation and questionnaires. Based on media development *cross number puzzle* To facilitate the cognitive dimension, it has a five stage process and obtains the following research results:

1) Analysis (Analisis)

The initial stage of this research is development *cross number puzzle* namely observation and interviews. Based on observations and interviews conducted by researchers, there is a problem, namely in classroom management, students feel bored and fed up with monotonous learning. The solution to dealing with this problem is the need for learning media that lasts a long time, has an attractive design and can be used for learning as well as playing so that students don't get bored so they can train critical thinking skills and media can facilitate students' cognitive dimensions. In this case, researchers provide new innovations in the form of concrete learning media *cross number puzzle*.

2) Design

This stage is a media product planning step *cross number puzzle* basic arithmetic material. With the development of this media, it is hoped that students will be able to understand basic arithmetic material to facilitate cognitive dimensions based on critical thinking skills. Results of media design planning *cross number puzzle* developed by researchers as follows:

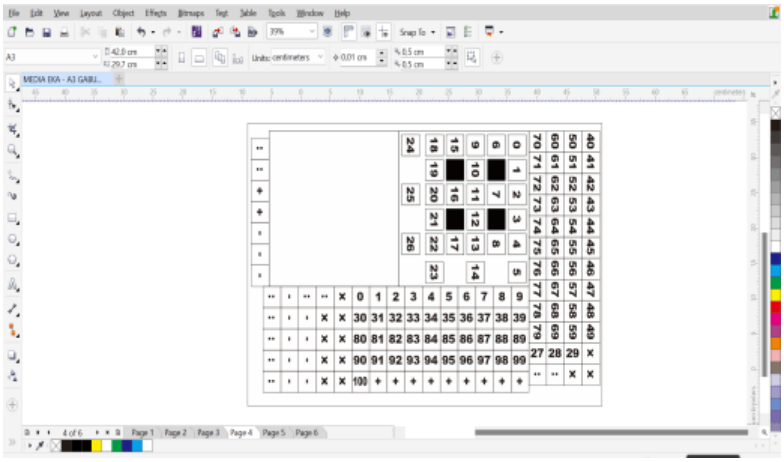


Figure 1. Media design *cross number puzzle* Of *Corel Draw*

After the design is in *corel draw* The next step is the media creation process *cross number puzzle* with the following results:



Figure 2. Results become media *Cross Number Puzzle*

Mathematics learning has different levels. At different levels, students have varying mathematical abilities. Media *Cross number puzzle* involves understanding arithmetic operations and basic mathematical skills regarding the types of levels. The level of difficulty design from previous research can be developed into student ability levels from low level to very high level, including as follows:

Table 2. Student Ability Level

Level 1 (Low)	Basic understanding of counting operations	Students' ability to answer simple questions involving simple addition, subtraction, multiplication and division such as making simple calculations A + B = __ Example: 5 + 8 = ___
Level 2 (Medium)	Further Understanding of Calculation Operations	Students' ability to solve problems with a medium level of difficulty, involving a combination of arithmetic operations, such as A ___ B = C Example: 5 ☐ 7 = 12.
Level 3 (Intermediate)	Understanding of Concepts and Combinations of Calculation Operations	Students' ability to handle more complex problems involving different sequences of arithmetic operations such as A + __ = B Example: (5 + __) = 16.
Level 4 (High)	Deep Understanding and Complex Problem Solving	Students' ability to solve problems by combining unknown initial number calculation operations such as __ + A = B. Example: __ + 2 = 10
Level 5 (Very High)	Advanced Troubleshooting	Students' ability to handle problems that require creative thinking and advanced problem solving, such as __ + __ = A Example: __ + __ = 12

source: Researcher, 2024

3) Media development (*Development*)

At this stage, validation is carried out by 2 people, namely material experts and media experts. Based on validation results material carried out with lecturers produces a percentage of 88% and media expert validation obtained results of 98%, both categorized as very good and very suitable for use. The following is a presentation of the results from the validation of material experts in table 2 and media experts in table 3.

Table 3. Material Expert Validation Analysis Results

No	**Rated aspect**	**Total score**
		Member
1	Material Contents	10
2	Question Difficulty	12
3	Operation	13
4	Creativity	9
Score obtained		**44**

Maximum score	**50**
Percentage	$\frac{Score\ obtained}{Maximum\ Score} \times 100\% = \frac{44}{50} \times$**100%** **= 88%**
Category	**Very Worth Using**

The material content assessment aspect received a score of 10 with a maximum score of 10. The difficulty aspect of the questions received a score of 12 with a maximum score of 15. The operational aspect received a score of 13 with a maximum score of 15. The creativity aspect received a score of 9 with a maximum score of 10. The total score obtained was 44 of the maximum score. 50 and a percentage score of 88%. Based on assessments from expert validators, the material is in the interval 81%-100% with the category "very suitable for use" meaning that the cross number puzzle media material on basic arithmetic calculation operations is very suitable to be developed in elementary schools.

Table 4. Results of Media Expert Validation Analysis

No	Rated aspect	Total score
		Member
1	Development	25
2	Design	10
3	Quality	9
4	Head	5
Score obtained		**49**
Maximum score		**50**
Percentage		$\frac{Score\ obtained}{Maximum\ Score} \times 100\% = \frac{49}{50} \times$ **100%** $=$ 98**%**
Category		**Very Worth Using**

The development assessment aspect received a score of 25 with a maximum score of 25. The design assessment aspect received a score of 10 with a maximum score of 10. The quality aspect received a score of 9 with a maximum score of 10. The content assessment aspect received a score of 5 with a maximum score of 5. The total score obtained was 49 of the maximum score. 50 and a percentage score of 98%. Based on the assessment from expert validators, the media is in the interval 81%-100% with the category "very suitable for use" meaning that the cross number puzzle learning media material on basic arithmetic calculation operations is very suitable for use and development in elementary schools.

4) Implemtation

At the implementation stage at SD Negeri Purworejo 02 with a total of 22 students as respondents. Implementation is carried out after all aspects are declared feasible by the validator. Media implementation *cross number puzzle* material on basic arithmetic calculation operations was carried out in class V. From the test scores obtained by the students with a total of 22 respondents, the T test was carried out to determine whether there was a difference in the average learning outcomes between *pretest* and *posttest* where after the application of the media *cross number puzzle* to facilitate the cognitive dimension of basic arithmetic material. Calculation of the t test using *software* SPSS V.20.

Table 6. SPSS V.20 T test results

Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Pretest	59.27	22	9.372	1.998
PostTest	89.64	22	6.835	1.457

Results from descriptive statistical data from values *pretest* and *posttest* with the number of respondents being 22 students, it can be seen that there is a difference in the average learning outcomes between *pretest* and *posttest* where after the application of the media *cross number puzzle* to facilitate the cognitive dimension of students' basic arithmetic material to increase.

Paired Samples Correlations

	N	Correlation	Say.
Pretest & PostTest	22	.257	.248

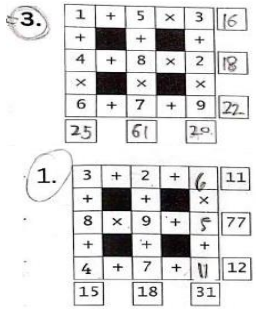
The results from the table above show the results of the correlation test or relationship between the two data *pretest* and *posttest*. Based on the correlation coefficient value of 0.257 with a significance of 0.248. Because the significance value is 0.248 > 0.05, it can be said that there is no relationship between the variables *pretest* and *posttest*.

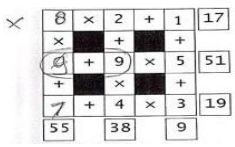
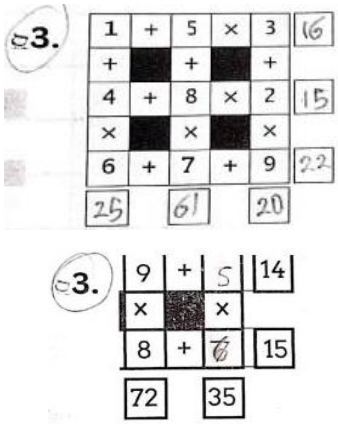
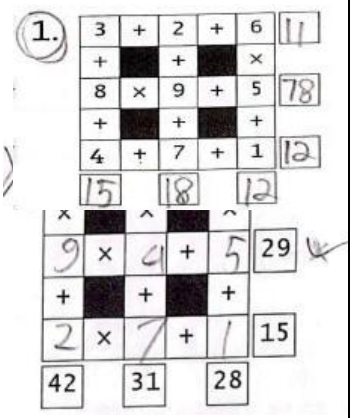
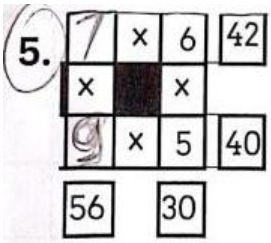
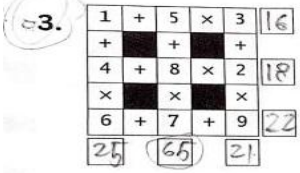
Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pretest - PostTest	-30.364	10.078	2.149	-34.832	-25.895	-14.131	21	.000

Based on the results of obtaining value *pretest* and *posttest* students can be seen in testing *Paired Samples Test* using a significance level of a = 5% or 0.05. T calculated with a negative value shows a result of -14,131 and T table is searched with a = 5% : 2 = 2.5% or 0.025 with degrees of freedom or df namely n-1 or 22-1 = 21. So we get a T table of 2,080 (see in t table). Thus, because the calculated t value is 14.131 > t table 2.080 and the result is significant (2-tailed) 0.000, then according to the basis for decision making above it can be concluded that H0 is rejected and Ha is accepted. So it can be concluded that there is a significant influence or difference in the average between the results *pretest* and *posttest*.

Table 4. 11 Errors in working on LKPD questions by group

Group	LKPD	Information	Conclusion
Group 1		In group 1, when working on LKPD questions, there were errors, namely at levels 1 and 3. The errors made were errors in calculating. Students are less careful in calculating. Error number 1 is level 3 error in calculating or computing.	The weakness of students in group 1 working on levels 1 and 3 is in calculating less accurately.

Group 2		The error made by group 2 in working on the LKPD questions was an error in calculating. Students are less skilled in calculating and less careful.	Students make mistakes in calculating.
Group 3		In group 3, when working on LKPD questions, there were errors, namely at levels 1 and 3. The errors made were errors in calculating. Students are less careful in calculating. Error number 1 is level 3 error in calculating or computing.	Students make mistakes in calculating.
Group 4		In group 4, when working on LKPD questions, there were errors, namely at levels 1 and 5. The errors made at level 1 were errors in calculating. Errors at level 5 are procedural errors. Students make mistakes in taking solution procedures in calculating and students are not careful.	Students make errors in calculating and procedural errors.
Group 5		In group 5, when working on LKPD questions, there was an error, namely at level 3. The error made was not being careful in calculating.	Students make mistakes in calculating.
Group 6		In group 6, when working on LKPD questions, there were errors, namely at level 1. The errors made were errors in calculating.	Students make mistakes in calculating.

Source: Researcher, 2024

Based on the results of the discussion of the data from working on questions on the LKPD obtained in the research, conclusions can be drawn. Based on the results of the data from working on the LKPD, it was found that students were working with calculation errors and procedural errors. Types of counting errors, viz students who are not careful in calculating do not continue the calculations and students make mistakes in writing down the results of calculations. Procedural errors are students' errors in using mathematical concepts, wrong steps in taking the solution. Identifying these types of errors is important to assist teachers in designing appropriate interventions, so as to help students improve their numeracy skills.

5) Evaluation

The evaluation stage is aimed at final improvements *cross number puzzle* as a learning medium. Evaluation and improvement are carried out after the product has gone through the revision stage. Evaluation is obtained from assessments given by media experts and material experts so that the product developed can be refined so that it is suitable for use on a larger scale. Student response questionnaires were given after teaching and learning activities regarding media *cross number puzzle* on basic arithmetic material with cognitive dimension ability levels. Each question has the answer "Yes" with a score of 1 or "No" with a score of 0. The following are the results of the analysis of student responses to the media *cross number puzzle*:

Table 5. Student Responses

No.	Score Earned	Maximum Score	Percentage
1.	21	22	$\frac{21}{22} \times 100\% = 95{,}4\%$
2.	21	22	$\frac{21}{22} \times 100\% = 95{,}4\%$
3.	20	22	$\frac{20}{22} \times 100\% = 90{,}9\ \%$
4.	21	22	$\frac{21}{22} \times 100\% = 95{,}4\%$
5.	21	22	$\frac{21}{22} \times 100\% = 95{,}4\%$
6.	22	22	$\frac{22}{22} \times 100\% = 100\%$
7.	19	22	$\frac{19}{22} \times 100\% = 86{,}3\%$
8.	20	22	$\frac{20}{22} \times 100\% = 90{,}9\%$
9.	21	22	$\frac{21}{22} \times 100\% = 95{,}4\%$
10.	21	22	$\frac{21}{22} \times 100\% = 95{,}4\%$
Number of Percentages Obtained			940,5%
Number of Percentages Obtained			1000
Rate-rate			94,05%
The number of students			22 Students

CONCLUSION

Results of research and development of learning media *cross number puzzle* basic arithmetic material for elementary schools, namely to produce media that is suitable for use in the teaching and learning process, validation of material experts and media experts is needed as well as a questionnaire on student and teacher responses to learning media. *cross number puzzle* basic arithmetic. In this research, material expert validation results were 93%, media expert validation results were 98%, teacher response questionnaires received 96% responses.

Media *cross number puzzle* declared valid or very suitable for use based on the results of assessments carried out by material experts and media experts. Apart from that, the results of research conducted using concrete media obtained a positive response from class V students as evidenced by the differences in results *pretest* and *posttest* which was calculated using SPSS to obtain results that show media development *cross number puzzle* very suitable for use to facilitate the cognitive dimensions of elementary school students' basic arithmetic material.

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