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The effect of using tangram-based puzzle media on students' learning interest and creative thinking skills

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Abstract

This present study aims to determine the effect of tangram-based puzzle media on improving fourth-grade students' learning interest and creative thinking skills. It is motivated by the issue of low interest in learning mathematics and the limited availability of concrete learning media, which often leads to conventional teaching methods. This study employs a One-Group pretest-posttest design. Data were collected through interviews, written tests, questionnaires, and documentation. The study results indicate that tangram-based puzzle media successfully fostered and maintained students' learning interest, as evidenced by increased student attention, interest in learning, feelings of pleasure, and increased student involvement. A significant increase was also observed in creative thinking skills, including enhancements in fluency, flexibility, originality, and elaboration skills. The research results indicate that increased interest in learning facilitates the practical understanding of quadrilateral concepts and develops creative thinking skills. Thus, Tangram-based puzzle media are a valuable and innovative learning tool to enable more interactive mathematics learning and develop higher-order thinking skills.

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1. Introduction

Law No. 20 of 2003 states that education aims to develop intellectually intelligent individuals with faith, good morals, and skills that meet the demands of the times. As a crucial science in achieving national education goals, mathematics has been taught from elementary school through higher education. However, many students consider mathematics a complex subject. This is due to a lack of understanding of basic concepts, less enjoyable learning experiences, and low motivation in the learning process (Manik et al., 2022). Teaching

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mathematics properly will sharpen thinking and reasoning skills. Therefore, students should have a strong interest in learning mathematics (C. Sarah et al., 2021).

Learning interest is a specific type of motivation that drives an individual to have a stable and continuous interest and inclination toward particular subjects, such as mathematics or languages (L. Zhao et al., 2024). Students' learning interests are one of the main factors in determining the success of the learning process. A high learning interest enables students to concentrate more easily and understand the material, while a low learning interest can hinder the understanding of lesson concepts (Ferlina & Fratiwi, 2024). By definition, learning interest is a form of desire that arises from willingness accompanied by attention and directed activity, which ultimately creates a sense of enjoyment and triggers positive behavioural changes in knowledge, attitudes, and skills (Barimbing et al., 2022).

The participation and enthusiasm of students in learning significantly impact the smoothness and effectiveness of learning activities. Students with a high interest in learning tend to show a greater level of creativity (Yuniharto & Rochmiyati, 2022). To equip students to face future challenges, the skills to think creatively become essential to develop from an early age (Van Hooijdonk et al., 2023). The skills to think creatively in mathematics refer to students' capacity to solve mathematical problems with diverse ideas, create various solutions, develop new forms, and produce accurate answers (Putri & Suripah, 2022). Thus, students who possess strong mathematical creative thinking skills will be able to solve mathematical problems correctly (Lutfia et al., 2023).

In the learning process, it is commonly found that the conditions are often monotonous and centred on verbalism, where learners tend to be passive, only playing the role of recipients of learning from the teacher through lectures. The lack of activities, such as discussions, is not ideal, as it can lead to passive and static learners, which can negatively impact students' academic performance (Nurfadhillah et al., 2021). Therefore, efforts to increase students' interest in learning mathematics heavily depend on applying innovative and interactive learning media. The application of attention-grabbing press can serve as one solution to facilitate the understanding of mathematical concepts, which are often perceived as complicated (Lutfiana, 2022).

Learning media play a crucial role in facilitating the delivery of messages during the learning process and in achieving the established learning objectives (Utami et al., 2024). Therefore, learning media should be tailored to the studied concept or material. The appropriate use of learning media can affect the quality of the learning process and the results achieved (Kholisah, 2024). Learning media serve as an aid and can stimulate students' interest and motivation to learn, reduce excessive talking, and foster students' reasoning in the mathematics learning process. Concrete and interactive learning media can encourage the development of various cognitive skills and promote active student participation in learning, while also addressing the limitations of existing conventional teaching methods (Y. Zhao et al., 2023).

Based on data from pre-research interviews with classroom teachers and fourth-grade students, it was found that students' interest in learning mathematics is still low. Students expressed that mathematics lessons are considered complicated; some students stated that they are less interested in the subject. As a result, students tend not to pay attention during the teacher's instruction, and they feel insecure and less motivated because they compare their grades with those of their peers.

Meanwhile, the fourth-grade homeroom teacher conveyed the same thing, often relying on lecture methods and assignments. The lack of concrete learning media in delivering the material on quadrilaterals results in students becoming passive and less actively involved in the

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learning process, causing them to accept whatever the teacher conveys without engaging in independent exploration.

Considering the interview results above, teachers should select suitable media to ensure that learning is not merely a collection of concepts. One approach is to utilise educational media that stimulate student interest in learning, creativity, and learning outcomes, particularly in the context of quadrilaterals.

2. Literature Review

A recent study in mathematics education consistently emphasises the significance of interest in learning and creative thinking skills for students' success (Ferlina & Fratiwi, 2024; Yuniharto & Rochmiyati, 2022). However, various studies indicate that students' interest in mathematics, especially at the elementary school level, tends to be low. This is caused by several factors, such as a lack of understanding of basic concepts, less engaging learning experiences, and low motivation (Manik et al., 2022). This condition is reinforced by conventional teaching methods that often rely solely on lectures and assignments, which tend to make students passive and less actively involved in the learning process (Nurfadhillah et al., 2021).

Several studies have demonstrated that the use of interactive and visually appealing media can significantly enhance learning interest and aid students in understanding complex mathematical concepts (Lutfiana, 2022; Utami et al., 2024). For example, Kholisah's (2024) research highlights the importance of aligning media and teaching materials for the quality of the learning process and its outcomes. However, identifying literature gaps suggests that further research is needed on the effectiveness of implementing concrete learning media, such as tangram-based puzzle media, in increasing learning interest and enhancing creative mathematical thinking skills in geometry materials, particularly quadrilaterals, in elementary schools that are not accustomed to using such media. Tangram is a type of puzzle where, given a set of polygons, students must arrange them on a surface so that the combination of the pieces forms the target polygon (Minamisawa et al., 2023).

Based on the above description, it is crucial to implement learning media that serve as a teaching aid and stimulate students' interest, motivation, and skills to solve problems creatively. This study aims to fill that gap by investigating the in-depth effect of tangram-based puzzle media on enhancing students' learning interest and mathematical creative thinking skills related to quadrilateral materials. This material is an essential part of the basic mathematics curriculum, but it is often presented abstractly, especially in school environments that have not adopted similar media.

The research conducted by Sirajuddin et al. (2023) entitled "The Use of Tangram Media to Enhance Interest and Learning Outcomes in Fourth-Grade Mathematics" and relevant research by (S. Sarah & Shalihah, 2023) entitled "The Effect of Tangram Media on Students' Interest in Learning Flat Shapes at MI Siti Mariam" has shown the effectiveness of using Tangram media in increasing interest in learning mathematics on flat shapes material. Additionally, the research conducted by Pratama & Hasanah (2024) "The Effect of Interactive Learning Media on Students' Interest in Science Subjects in Elementary School" indicates that interactive learning media impact students' interest in learning. This research provides novelty through its specific focus. The uniqueness of this study lies in the application of tangram-based puzzle media that is specifically tailored to analyse not only the increase in learning interest but also the development of mathematical creative thinking skills among fourth-grade students, particularly

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in the topic of quadrilaterals. Additionally, this study addresses the learning conditions still dominated by verbalistic methods and the minimal use of concrete media in the research location, providing practical contributions to a specific learning environment.

The research conducted by Wardani & Putra (2024) entitled "The Use of Tangram Media on Flat Geometry Material Against the Creative Mathematical Thinking Skills of Elementary School Students" analyses the effectiveness of Tangram on creative thinking. However, it has not integrated the aspect of learning interest as a variable that is also important to enhance. Additionally, the research conducted by Pratama & Hasanah (2024) has emphasised the importance of interactive media for learning interest. However, that research did not specifically analyse tangram media or its application to quadrilateral material.

Thus, a comprehensive study that analyses how tangram-based puzzle media can simultaneously enhance learning interest and mathematical creative thinking skills in quadrilaterals at elementary schools that are not yet accustomed to using this media has not yet been conducted. This gap underscores the need for more integrated and contextually relevant research.

Based on the identified research gaps, the main research objective is to analyse and describe the impact of tangram-based puzzle media on students' interest in learning and their creative thinking skills during mathematics lessons on quadrilaterals in grade IV.

3. Method

Data collection was conducted in February 2025, coinciding with the academic year 2024/2025. As a methodological approach, the type of research used is quantitative research. The chosen design is an experiment with a one-group pretest-posttest model, allowing the researcher to measure changes in the same group before and after the treatment. The reason for choosing the one-group pretest-posttest design is that it is easy to implement and suitable for preliminary research (pre-experimental) to determine the impact of tangram-based puzzle media on students' interest in learning and their creative thinking skills during mathematics lessons on the topic of quadrilaterals in grade IV.

The research subjects involved 31 fourth-grade students, 19 males and 12 females. The use of this sample follows the minimum criteria, because the minimum number of research subjects for quantitative research is 30 (Kerlinger & Lee, 2000). The collected data included the students' interest in learning mathematics and their creative thinking abilities in mathematics.

Data collection techniques refer to systematic procedures to obtain relevant information or observations from respondents or research subjects. To collect data, researchers employed a range of instruments, including interviews, questionnaires, written tests, and documentation. Questionnaires are used to measure students' interest in learning mathematics, which are composed of 20 statements according to indicators of interest in learning and scored using a Likert scale. Meanwhile, written tests are used to measure students' creative thinking abilities, consisting of pre-test and post-test questions, each containing 20 multiple-choice questions that are valid and reliable. Research documentation in the form of photos serves as supporting evidence that the researcher used tangram-based puzzle media.

The data analysis techniques consisted of four stages. Data description was conducted to collect information on the students' learning interests and creative thinking abilities through pre-test and post-test, presented as descriptive tables, to provide an initial overview of the distribution. A descriptive comparison between the pre-no-test and post-no-test is included, which involves calculating the average, standard deviation, and gain score. The prerequisite test

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to be conducted is the normality test. The purpose of the normality test is to examine whether the data is normally distributed or not, as parametric analysis techniques usually require distributed data (Sugiyono, 2019). Based on the results of the normality test, a paired samples t-test was then conducted to compare the means of two related or paired groups (Pallant, 2020). The paired-sample t-test was used to determine whether there was a significant difference in the students' creative thinking abilities after being given treatment through learning tangram-based puzzle media, as shown in Figure 1.

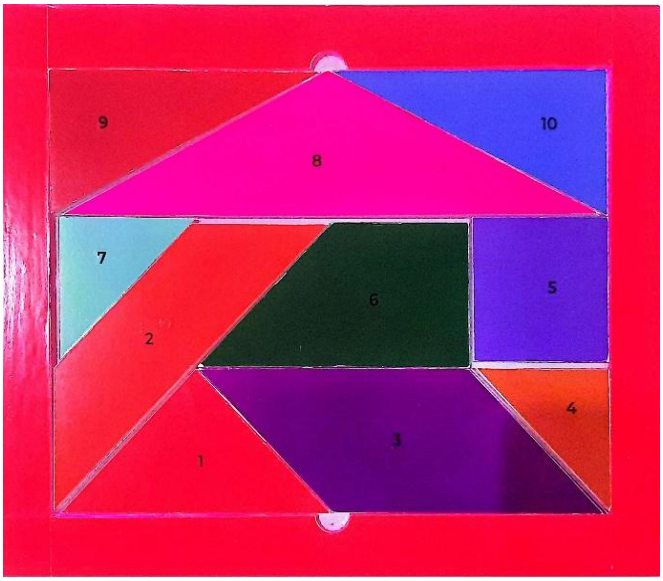

Figure 1. Tangram-based puzzle media

4. Results

The interest of students in learning mathematics using tangram-based puzzle media was measured using four indicators of learning interest according to Slameto in Mahdalena (2022), namely students' attention, interest in learning, feelings of pleasure, and involvement in mathematics lessons, especially in learning about quadrilaterals. These four indicators determine the extent of students' interest in mathematics. Additionally, they were used to understand and analyse the effect of tangram-based puzzle media on improving or changing students' learning interests. The results of the study on the learning interest of fourth-grade students before using tangram-based puzzle media are depicted in Table 1.

Table 1. The average score results of the pre-non-test indicator questionnaire on mathematics learning interest of fourth-grade students

No.	Indicators	Statement	Score					Total score	Percentage	Category
			SS	S	RR	TS	STS			
1	Student attention	1	0	24	7	0	0	117	75%	Good
		2	0	16	15	0	0	109	70%	Good
		3	0	18	11	2	0	109	70%	Good
		4	0	11	13	7	0	97	63%	Good
		5	1	19	10	1	0	113	73%	Good
	Average		**1%**	**65%**	**31%**	**4%**	**0%**	**545**	**70%**	**Good**

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No.	Indicators	Statement	Score					Total score	Percentage	Category
			SS	S	RR	TS	STS			
2	Student interest in learning	6	0	6	19	6	0	93	60%	Quite Good
		7	0	16	9	6	0	103	66%	Good
		8	0	20	8	3	0	110	71%	Good
		9	0	23	6	2	0	114	74%	Good
		10	0	20	8	3	0	110	71%	Good
	Average		**0%**	**64%**	**28%**	**8%**	**0%**	**530**	**68%**	**Good**
3	The feeling of pleasure	11	0	15	11	4	1	102	66%	Good
		12	0	11	14	6	0	98	63%	Good
		13	0	14	13	4	0	103	66%	Good
		14	1	25	4	1	0	119	77%	Good
		15	1	12	9	9	0	98	63%	Good
	Average		**2%**	**59%**	**29%**	**9%**	**0%**	**520**	**67%**	**Good**
4	The student's involvement	16	0	10	18	3	0	100	65%	Good
		17	0	9	19	3	0	99	64%	Good
		18	1	21	5	3	1	111	72%	Good
		19	0	21	7	3	0	111	72%	Good
		20	1	22	8	0	0	117	75%	Good
	Average		**2%**	**62%**	**32%**	**4%**	**0%**	**538**	**69%**	**Good**
	Average		1%	62%	30%	6%	0%	2133	69%	Good
	Highest score		1%	65%	31%	4%	0%	545	70%	Good
	Lowest score		2%	59%	29%	9%	0%	520	67%	Good

Based on the Table 1, it is known that the interest level of fourth-grade students is categorised as Good. This is reflected in the overall average percentage of 69% from 31 respondents. The indicator with the highest average percentage is the students' attention indicator, which scores 71%, meaning that the students have a good level of attention while participating in learning. Meanwhile, the lowest achievement is found in the feeling of pleasure indicator, with an average percentage of 67%. Although it is still categorised as good, this score indicates that students have a lower enjoyment level than other learning interest indicators. Additionally, statement number six in the student interest indicator has the lowest percentage, with a score of 60% categorised as reasonably good. This highlights the presence of indicators that suggest students' learning interests require further attention. The results of the study on the learning interest level of fourth-grade students after using tangram-based puzzle media are depicted in Table 2.

Table 2. Average score results of post-non-test indicators of the questionnaire on math learning interest of fourth grade students

No.	Indicators	Statement	Score					Total score	Percentage	Category
			SS	S	RR	TS	STS			
1	Student attention	1	13	15	3	0	0	134	86%	Excellent
		2	6	20	5	0	0	125	81%	Excellent
		3	10	17	4	0	0	155	84%	Excellent
		4	3	15	9	4	0	110	71%	Good
		5	14	14	3	0	0	135	87%	Excellent

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No.	Indicators	Statement	Score					Total score	Percentage	Category
			SS	S	RR	TS	STS			
	Average		**36%**	**51%**	**11%**	**1%**	**0%**	**634**	**82%**	**Excellent**
2	Student interest in learning	6	6	19	6	0	0	124	80%	Good
		7	12	15	4	0	0	132	85%	Excellent
		8	8	11	9	3	0	117	75%	Good
		9	9	16	5	1	0	126	81%	Excellent
		10	15	12	3	1	0	134	86%	Excellent
	Average		**39%**	**46%**	**13%**	**2%**	**0%**	**633**	**82%**	**Excellent**
3	The feeling of pleasure	11	14	13	3	1	0	133	86%	Excellent
		12	13	13	3	2	0	130	84%	Excellent
		13	12	14	5	0	0	131	85%	Excellent
		14	16	12	3	0	0	137	88%	Excellent
		15	10	16	2	3	0	126	81%	Excellent
	Average		**49%**	**41%**	**7%**	**2%**	**0%**	**657**	**85%**	**Excellent**
4	The student's involvement	16	7	14	10	0	0	121	78%	Good
		17	5	11	14	1	0	113	73%	Good
		18	10	19	2	0	0	132	85%	Excellent
		19	17	7	7	0	0	134	86%	Excellent
		20	18	11	2	0	0	140	90%	Excellent
	Average		**45%**	**39%**	**16%**	**0%**	**0%**	**640**	**83%**	**Excellent**
	Average		43%	44%	12%	1%	0%	2564	83%	Excellent
	Highest score		49%	41%	7%	2%	0%	657	85%	Excellent
	Lowest score		39%	46%	13%	2%	0%	633	82%	Excellent

The second indicator used to measure students' learning interest is their interest in the mathematics learning process of quadrilaterals, as demonstrated through tangram-based puzzles. The average score is 633, with a percentage of 82%, indicating that the increased interest of fourth-grade students in learning after implementing tangram-based puzzles is classified as very good. The level of interest that has risen significantly is reflected in the statement that students feel enthusiastic during mathematics lessons, achieving a score of 60% in the pre-test, which is considered relatively good, and then rising to 80%, categorised as good. The learning process that emphasises hands-on experience and active involvement gives students the autonomy to explore and find solutions independently. The feeling of mastery and the freedom to examine directly enhances students' intrinsic interest in the material. This is also clearly reflected in the statement that students feel challenged to complete problems related to quadrilaterals, with an obtained percentage of 81%.

The third indicator used to measure students' interest in learning is the feeling of happiness during the mathematics learning process, which applies tangram-based puzzle media, and obtained an average score of 657 with a percentage of 85%, categorised as very good. The high interest level is illustrated by the highest score achievement in this indicator, where students feel happy and satisfied when successfully solving mathematics problems, with 88% in the excellent category. This shows that students' success in assembling puzzle pieces into flat quadrilateral shapes triggers a sense of satisfaction with their achievements, influencing their motivation to continue learning. This is also in line with the high percentage in the eleventh statement, which indicates that students enjoy attending math lessons, especially those on quadrilaterals, with a rate of 86% in the excellent category. Students do not feel bored when

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learning about the types of quadrilaterals in math lessons, with a percentage of 84% that is considered outstanding.

The last indicator used to measure students' interest in learning mathematics on quadrilaterals, using Tangram-based puzzle media, yields an average of 83%, categorised as excellent. The level of student engagement, categorised as exceptional, is evident in statements about students actively discussing in class with their friends, engaging in group activities during mathematics lessons, and enjoying helping classmates who have difficulties understanding the material on quadrilaterals in mathematics lessons. Meanwhile, the lowest score is found in the statement about students being brave enough to answer questions posed by the teacher regarding quadrilaterals in mathematics lessons, achieving a percentage of 73%, categorised as good. However, this percentage still shows a significant increase in the students' courage to interact with the teacher compared to the initial condition.

The research results show an excellent percentage for each indicator of learning interest. This proves that the students responded positively to tangram-based puzzle media in mathematics lessons on quadrilaterals.

Students' creative thinking abilities are measured to determine the effect of tangram-based puzzle media. This measurement of creative thinking abilities is divided into four indicators, based on Munandar (2009, as cited in Hidayat et al., 2023), which include fluent thinking, flexible thinking, original thinking, and elaboration skills. Fluent thinking refers to the skills to generate a variety of ideas, flexible thinking relates to the skills to produce ideas from different perspectives, original thinking refers to the uniqueness of an idea, and elaboration skills refer to the level of detail contained in an idea (Van Hooijdonk et al., 2023). These four indicators are used to determine the extent of students' creative thinking abilities in learning the quadrilateral material and to analyse the influence of tangram-based puzzle media on their improvement or change in students' creative thinking abilities. Table 3 presents the average scores of the innovative thinking skills indicators for fourth-grade students before using tangram-based puzzle media are presented in Table 3.

Table 3. Average score results of the pre-test for the indicator of mathematical creative thinking skills of 4th-grade students

No.	Indicators	Q. No.	Number of respondents				Correct answer	Correct number	Percentage correct (%)	Categories
			Opt. A	Opt. B	Opt. C	Opt. D				
1	Fluent thinking	1	3	1	25	2	C	25	81%	Very easy
		2	24	6	0	1	A	24	77%	Easy
		3	23	2	4	2	A	23	74%	Easy
		4	10	2	8	11	D	11	35%	Difficult
		5	7	19	1	4	B	19	61%	Easy
	Average		**43%**	**19%**	**25%**	**13%**		**102**	**66%**	**Easy**
2	Flexible thinking	6	16	7	8	0	B	7	23%	Difficult
		7	5	8	13	5	A	5	16%	Very difficult
		8	3	14	4	10	A	3	10%	Very difficult
		9	15	7	2	7	A	15	48%	Currently
		10	4	7	10	10	B	7	23%	Difficult
	Average		**28%**	**28%**	**24%**	**21%**		**37**	**24%**	**Difficult**

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No.	Indicators	Q. No.	Number of respondents				Correct answer	Correct number	Percentage correct (%)	Categories
			Opt. A	Opt. B	Opt. C	Opt. D				
3	Original thinking	11	4	9	16	2	C	16	52%	Currently
		12	14	8	7	2	C	7	23%	Difficult
		13	17	7	3	4	B	7	23%	Difficult
		14	0	18	6	7	D	7	23%	Difficult
		15	10	9	0	12	D	12	39%	Difficult
	Average		**29%**	**33%**	**21%**	**17%**		**49**	**32%**	**Difficult**
4	Elaboration skills	16	11	3	10	7	A	11	35%	Difficult
		17	13	5	6	7	D	7	23%	Difficult
		18	17	2	5	7	A	17	55%	Currently
		19	9	8	7	7	D	7	23%	Difficult
		20	1	15	5	10	D	10	32%	Difficult
	Average		**33%**	**21%**	**21%**	**25%**		**52**	**34%**	**Difficult**
	Average		33%	25%	23%	19%		240	39%	Difficult
	Highest score		43%	19%	25%	13%		102	66%	Easy
	Lowest score		28%	28%	24%	21%		37	24%	Difficult

Table 3 shows that students' creative thinking skills in the pre-test fall into the difficult category with an average correct percentage of 39%. This data shows that before the implementation of the tangram-based puzzle media, students face significant difficulties, particularly in the indicators of flexible thinking, original thinking, and elaboration skills.

Table 4. Average post-test scores results of indicators for the creative mathematical thinking skills of 4th-grade students

No.	Indicators	Q. No.	Number of respondents				Correct answer	Correct number	Percentage correct (%)	Categories
			Opt. A	Opt. B	Opt. C	Opt. D				
1	Fluent thinking	1	0	0	31	0	C	31	100%	Very easy
		2	29	1	0	1	A	29	94%	Very easy
		3	30	0	1	0	A	30	97%	Very easy
		4	4	3	12	12	D	12	39%	Difficult
		5	10	19	1	1	B	19	61%	Easy
	Average		**47%**	**15%**	**29%**	**9%**		**121**	**78%**	**Easy**
2	Flexible thinking	6	7	20	2	2	B	20	65%	Easy
		7	22	2	4	3	A	22	71%	Easy
		8	11	19	1	0	A	11	35%	Difficult
		9	19	4	3	5	A	19	61%	Easy
		10	5	22	3	1	B	22	71%	Easy
	Average		**41%**	**43%**	**8%**	**7%**		**94**	**61%**	**Easy**
3	Original thinking	11	2	1	25	3	C	25	81%	Very easy
		12	9	1	20	1	C	20	65%	Easy
		13	4	26	0	1	B	26	84%	Very easy

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No.	Indicators	Q. No.	Number of respondents				Correct answer	Correct number	Percentage correct (%)	Categories
			Opt. A	Opt. B	Opt. C	Opt. D				
		14	2	6	12	11	D	11	35%	Difficult
		15	3	1	0	27	D	27	87%	Very easy
	Average		**13%**	**23%**	**37%**	**28%**		**109**	**70%**	**Easy**
4	Elaboration skills	16	27	0	2	2	A	27	87%	Very easy
		17	5	6	4	16	D	16	52%	Currently
		18	22	2	3	4	A	22	71%	Easy
		19	2	1	1	27	D	27	87%	Very easy
		20	1	18	0	12	D	12	39%	Difficult
	Average		**37%**	**17%**	**6%**	**39%**		**104**	**67%**	**Easy**
	Average		35%	25%	20%	21%		428	69%	Easy
	Highest score		47%	15%	29%	9%		121	78%	Easy
	Lowest score		41%	43%	8%	7%		94	61%	Easy

Table 4 presents the results of the creative thinking skills of fourth-grade students after using tangram-based puzzle media are presented in Table 4. The data description of creative thinking skills in the post-test shows an increase in the students' creative thinking abilities, with a percentage of 69%, indicating a significant improvement from the difficult category to the easy category. The improvement occurs evenly across all indicators of creative thinking skills in the easy category.

The first indicator of creative thinking skills is the ability to think fluently. On average, 66% is obtained in the pre-test, then increases to 78% in the post-test results. However, there is a decline in several students, namely students 5, 3, and 12, who answered correctly in the pre-test but incorrectly in the post-test, resulting in a score of 0. This occurred in questions 2, 4, and 3, which could be caused by several factors, including misreading the questions, rushing, and anxiety about material already mastered. Question number 10, which explains the properties of a parallelogram and its similarity to other flat shapes, indicates flexible thinking, showing an increase, as 22 students answered correctly. This increase suggests that learning with Tangram-based puzzle media directly enhances students' skills to construct shapes.

Table 5. Descriptive data on creative thinking skills

Descriptive Statistics	N	Min	Max	Mean	Std. Deviation	N-Gain Score	Category
Creative Thinking Skills							
Pre-Test	31	20	60	38.71	10.643		
Post-Test	31	35	90	69.03	13.318	0.4969	currently

The third indicator used to measure students' creative thinking skills is originality of thought. The level of original thinking that has increased sufficiently is evident in the examples of questions 11, 12, 14, and 15, where students 2, 6, 1, and 11 initially answered incorrectly in the pre-test but then responded correctly in the post-test. The last indicator used to measure students' creative thinking skills is the skill of elaboration, which shows an average increase of 33 percentage points from 34% to 67% in the post-test. This increase indicates that students can generate ideas and develop and explain how to create a flat geometric shape. The results

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are presented in Table 5 based on the descriptive analysis of students' creative thinking abilities using SPSS 27 before and after implementing tangram-based puzzle media.

The descriptive analysis in the table above indicates a significant increase in creative thinking abilities, which falls into the moderate category, thus demonstrating the effectiveness of the application. The normality prerequisite test for creative thinking skills data uses the Shapiro-Wilk test in IBM SPSS 27. The results are presented in Table 6.

Table 6. Results of the normality test of creative thinking skills

Tests of Normality			
	Shapiro-Wilk		
	Statistic	df	Sig.
Creative Thinking Skills			
Pre-Test	0,965	31	0,382
Post-Test	0,953	31	0,189

Based on the results of the normality test in Table 6, it is evident that the significance value (Sig.) for both the pre-test and post-test is greater than 0.05. Therefore, the data on creative thinking skills in the pre-test and post-test are typically distributed. Furthermore, the data is analysed using a paired samples t-test with the following hypotheses: H_0: There is no significant difference in the creative thinking skills of students before and after using tangram-based puzzle media in mathematics learning on the topic of quadrilaterals for fourth grade, and H_a: there is a significant difference in the creative thinking skills of students before and after using tangram-based puzzle media in mathematics learning on the topic of quadrilaterals for fourth grade.

Table 7. Results of the dependent two-sample t-test learning interest

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Creative thinking Skills pretest – Creative thinking Skills posttest	-30,323	12,841	2,306	-35,033	-25,612	-13,148	30	0,000

The results of the paired samples t-test in Table 7 show a Sig. value of (0.000) < 0.05, therefore H0 is rejected and H1 is accepted. This indicates a statistically significant difference in students' creative thinking abilities before and after the implementation of tangram-based puzzle media. Thus, the treatment provides in the form of tangram-based puzzle media significantly improves students' creative thinking abilities.

The enhancement of the fourth-grade students' creative thinking abilities is also evident through the LKPD (Student Work Sheet) activities in the quadrilateral material, which is worked on in groups divided into five learning groups. Group LKPD is an effective medium for students to apply, develop an understanding of, and practice creative thinking skills related to various quadrilaterals through tangram-based puzzle media, as illustrated in Figures 2 and 3.

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Figure 2. Tangram-based puzzle media activities in the classroom

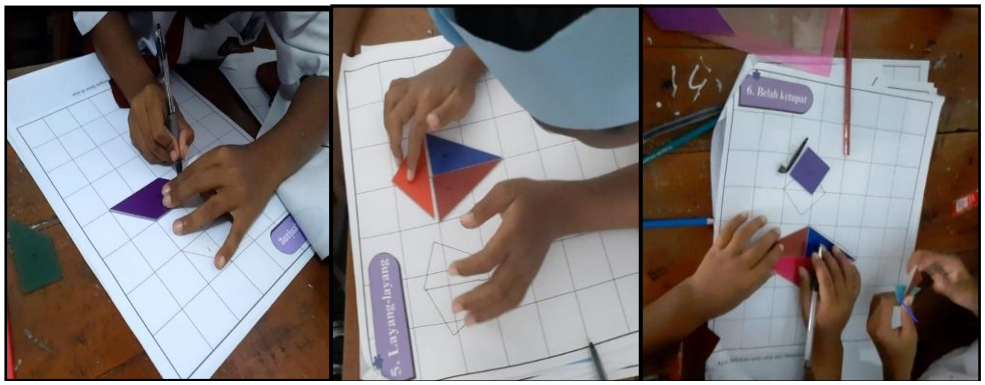

Figure 3. Tangram-based puzzle media activities in the classroom

Based on Figures 2 and 3, it is evident that students can produce various types of quadrilaterals using puzzle pieces. Through manipulating puzzle pieces, students can identify the types of quadrilaterals and learn about the properties of each type of quadrilateral. Students feel the four sides and four angles of a square and understand the parallelism in parallelograms and the non-right angles. Students actively discover the types of quadrilaterals by combining simpler shapes, which introduces an understanding of the composition and decomposition of planar shapes. Students indirectly apply the properties of planar shapes to solve problems; for example, when students try to form a rectangle, they need perpendicular and parallel sides. This makes math learning more concrete, interactive, and meaningful.

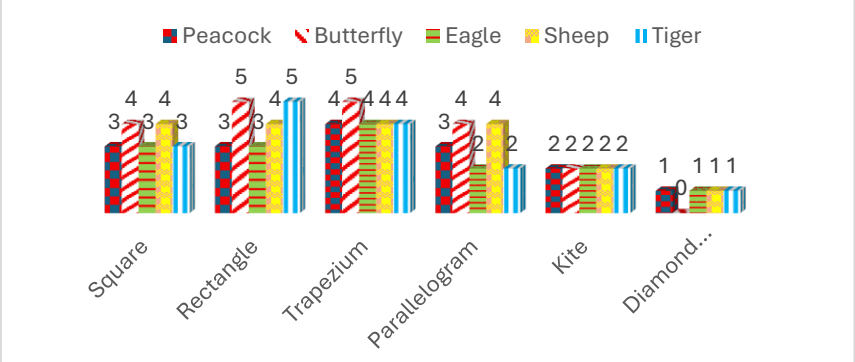

Figure 4. Diagram of rectangular acquisition results by the group

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The data in Figure 4 shows the number of variations in the arrangement of puzzle pieces among five student learning groups, including the peacock group, butterfly group, eagle group, sheep group, and tiger group, in forming types of quadrilaterals using tangram-based puzzle media. All groups demonstrate good fluency in thinking and elaboration skills in producing appropriate shapes. The butterfly group appears to excel in forming rectangles and trapezoids. The sheep group shows the same capacity with rectangles, parallelograms, and trapezoids. Meanwhile, the peacock, eagle, and tiger groups also show consistent results, indicating students' mastery of basic understanding.

In the indicators of flexible thinking and original thinking, a decline is identified in forming quadrilaterals, namely kites and rhombuses. This is due to the limitations of the tangram-based puzzle media used. This media can only create a maximum of two variations of kites and one variation of rhombuses. Nevertheless, all groups successfully find the correct and complete arrangements according to the variations that this medium could make. Although the available variations are limited, the Tangram media remains effective in helping students correctly identify types of quadrilaterals. In several groups, particularly the butterfly group, misconceptions are found in distinguishing between rhombuses and squares.

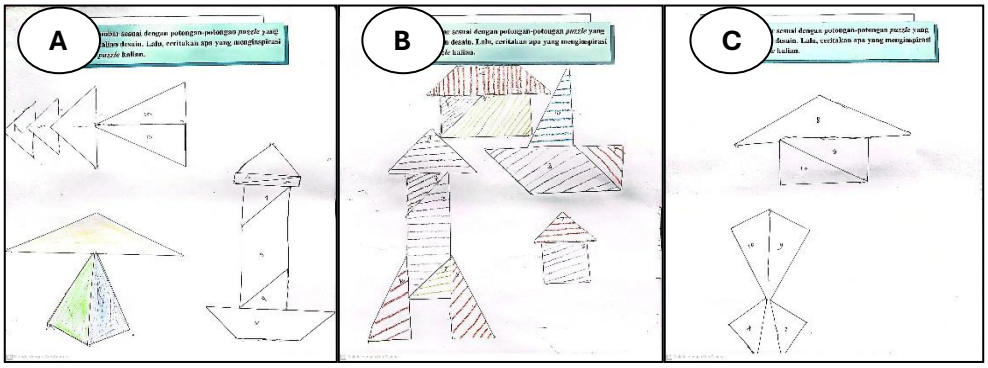

Figure 5. Results of the Group LKPD

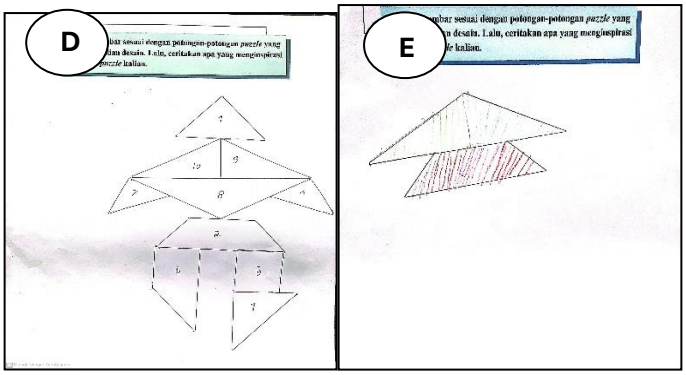

Figure 6. Results of the Group LKPD

Figures 5 and 6 display the results of the LKPD (Student Worksheet) completed by each fourth-grade group, which involves creating several designs using tangram puzzle pieces—Figure 5. A demonstrates fluency and flexibility in producing various designs with high originality—Figure 5. B presents fluency, flexibility, creativity, and high detail elaboration in its designs—Figure 5. C sufficiently shows indicators of original thinking in its work design—Figure

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6.D forms a design that demonstrates flexible and original thinking—Figure 6. E indicates the most limited level of creative thinking skills, as the resulting shapes are elementary without developing variations. The existence of various shapes and complexities generated by each group indicates a high level of involvement. Tangram-based puzzle media can attract students' interest, transforming mathematics learning from abstract to more concrete and interactive. Students can visualise how the puzzle pieces fit together, directly engaging their understanding of sides and angles.

5. Discussion

This research suggests that the use of tangram-based puzzle media significantly impacts students' interest in learning and developing creative thinking skills in mathematics, particularly in the topic of quadrilaterals for fourth-grade students. The analysis reveals a substantial increase in four indicators of student learning interest: attention, interest, enjoyment, and active engagement. Before the treatment, the enjoyment indicator recorded the lowest score, which has the potential to be the beginning of developing math anxiety (Gashaj et al., 2023). Students with anxiety tend to be more easily distracted and experience difficulties during tests (Imran et al., 2023). The use of tangram-based puzzle media in the mathematics learning process successfully stimulated this positive effect, thereby increasing motivation and reducing anxiety (Rambe et al., 2024). Therefore, tangram-based puzzle media can increase interest in learning mathematics.

The increased interest in learning among students aligns with the Science of Learning (SOL) principles in an active learning environment characterised by activity, engagement, meaningfulness, and social interaction (Scalise et al., 2025). Students directly manipulate and move puzzle pieces to solve problems, a form of active learning that requires student involvement and participation (Abdurahman et al., 2025). Tangram-based puzzle media implies a student-centred teaching method (Dewi & Lestari, 2021). Self-Determination Theory (SDT) is a metatheory emphasising the importance of intrinsic motivation, characterised by curiosity and determination. This theory examines the innate psychological needs essential for personal growth (Adriyendi, 2024). Tangram-based puzzle media can fulfil basic psychological needs that align with the SDT theory: autonomy and competence. Students feel capable and skilled in their self-skills when they successfully assemble various puzzle pieces. The visual design and characteristics of tangram-based puzzle media attract attention and stimulate curiosity, thus enhancing focus and on-task behaviour (Pagarra et al., 2022). Tangram-based puzzle media allows students to connect concrete experiences with abstract concepts, facilitating meaningful learning (Nufus et al., 2024). The interactions that occur during the learning process also encourage collaboration and discussion. The increased interest in learning subsequently affects students' practice behaviour. According to Hilz et al. (2025) and Wong et al. (2024), this serves as a mediator between anxiety and students' academic performance. High interest in learning promotes perseverance in studying and reduces avoidance behaviour in learning.

Based on the research results, tangram-based puzzle media is also effective in delivering square material, stimulating and developing students' creative mathematical thinking skills. The application of tangram-based puzzle media is one approach to mathematics learning that is concrete, interactive, and meaningful, which is highly needed in this era of globalization (Nufus et al., 2024). Creative thinking abilities reflect the fluency of cognitive ideas. Incorporating creative thinking into learning can help students overcome difficulties, encourage deeper understanding, and stimulate imagination (Smare & Elfatihi, 2025). This aligns with Wilkie (2024)

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and Van Hooijdonk et al. (2023), who confirm the positive relationship between fluency and originality in children. Thus, the more ideas generated, the greater the chance of finding original solutions in square material. This shows that tangram-based puzzle media is able to develop students' creative thinking skills.

Students can assemble puzzle pieces in various ways to form different types of quadrilaterals. The types of quadrilaterals include squares, rectangles, trapezoids, parallelograms, rhombuses, and kites (Akar & Işıksal-Bostan, 2022). According to Wilkie (2024), the importance of flexible thinking as an indicator of creative thinking skills in problem-solving with multiple solutions is similar to what students do when experimenting with tangram-based puzzle media. Creativity lies in students' skills to independently structure their thoughts and organise the problem-solving process in new ways (Bicer et al., 2025). Flexibility in mathematics refers to an individual's ability to adapt their way of thinking when faced with difficulties or obstacles, thereby generating various solutions or ideas (Suherman & Vidákovich, 2022).

The tangram-based media puzzle effectively triggers students' skills to think creatively and produce answers by forming squares. This success aligns with research (Astuti et al., 2021) interactive media can stimulate the thinking process, leading to original ideas. Students' skills to create distinctive designs align with the definition of originality by Van Hooijdonk et al. (2023), which states that creative works must be both original and valuable. As stated by Yılmaz & Tekerek (2024), manipulative media can involve reasoning strategies and problem-solving abilities that directly support the development of elaboration skills. According to Wilkie (2024), elaboration refers to the skills to modify or enhance aspects of a situation, as evident in actions such as substituting, combining, adapting, or rearranging. Furthermore, students' creative thinking abilities in mathematics should be given opportunities through lesson delivery activities (Bicer et al., 2024). This aligns with the process of trial and error and the adjustment of puzzle piece positions that students undertake while attempting to form different types of quadrilaterals.

As stated by Tsalitsah & Baalwi (2024), the skills to think creatively involve tangram media, which provides a concrete stimulus that encourages the exploration of various perspectives and familiarises oneself with new situations and problems. The characteristics of tangram leverage the combinatorial aspects of geometric shapes, making the resolution activities more engaging and complex (Yamada et al., 2025). In their research, Saleem & Aziz (2017) reinforce that the use of tangram puzzles significantly enhances students' achievements in learning, indicating that the improvement in creative thinking abilities is positively associated with material understanding and academic success. Students can manipulate and analyse various quadrilaterals, meaning their conceptual knowledge becomes deeper and more functional rather than limited to memorisation (Jumawan et al., 2024). Tangram-based puzzle media capture attention and motivation, develop psychomotor and intellectual capacities, stimulate creativity, and enhance students' self-confidence and reasoning (Botello Hurtado, 2022). Additionally, students possess holistic thinking skills that foster curiosity in learning (Kaynar & Kurnaz, 2024).

Overall, the study's results on hashtag-based puzzle media increased the desire to learn and creative thinking skills in mathematics. Other variables can influence students' interest in learning and innovative thinking, namely parental support and the facilities available to each student. This factor is present because this study used a one-group pre-test and post-test. Parental support and good learning facilities influence interest in learning and creative thinking. The more and better parental support and the availability of learning facilities, the more students are interested in learning mathematics and think creatively. This follows previous

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research, which revealed that factors that influence learning interest include family support and learning facilities (Mesra et al., 2021). Research conducted by (Nugraha et al., 2025; Pravitasari, 2020) indicates that one of the factors that influences children's creative thinking is parental support.

This research contributes practically to solving problems related to learning media, learning interests, and students' creative thinking. This research contributes to developing interactive and engaging learning media for students to learn mathematics. This media is also inexpensive, making it accessible to all students. This research also develops students' creative thinking skills.

6. Conclusion and Implications

Based on the research results and discussions, tangram-based puzzle media positively and significantly impact fourth-grade students' interest in learning and developing creative thinking abilities, particularly about quadrilaterals. This increase indicates that the use of tangram-based puzzle media not only facilitates the conceptual understanding of quadrilateral material but also stimulates students' cognitive flexibility and problem-solving skills. Although there are individual variations, the overall increase demonstrates the effectiveness of the media as an interactive and student-centred learning tool. For future research, it is recommended to explore the efficacy of tangram-based puzzle media at different educational levels or subjects. This could involve developing tangram-based puzzle media to address the limitations of shape variations and identified misconceptions, and consider external factors that affect students' concentration during the learning process.

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