Prima: Jurnal Pendidikan Matematika
Vol. 9, No. 2, May 2025, pp. 349 - 364
P-ISSN: 2579-9827, E-ISSN: 2580-2216
Web: http://jurnal.umt.ac.id/index.php/prima

DEVELOPMENT OF A STEAM-BASED E-LKPD TO ENHANCE STUDENTS' CREATIVE THINKING IN GEOMETRY TRANSFORMATIONS

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Abstract

In the age of information and growing competition, the ability to think creatively in mathematics and other subjects is a valuable life skill. Students' poor capacity for creative thought is a result of suboptimal learning strategies and processes. STEAM learning emerged as an effort to overcome the shortcomings of previous learning methods. By creating educational materials in the form of E-LKPD (Electronic Learners' Worksheet) based on STEAM (Science, Technology, Engineering, Arts, and Mathematics), this study seeks to enhance students' ability for creative thought. The STEAM-based E-LKPD is designed using *Liveworksheet*. The method used in this research is the ADDIE method (Analysis, Design, Development, Implementation, Evaluation). The trial took place in one of Jambi City's junior high schools. by taking one of the ninth-grade classes at the school with a total of 28 students. Data analysis was measured using a Likert scale, and then the results of the creative thinking ability test were calculated using the N-Gain formula. The results showed that the STEAM-based E-LKPD met the product quality criteria, which included validity, practicality, and effectiveness. It was discovered that the design validity achieved a percentage of 91.4% with "very valid" criteria, while the percentage of material validity was 80% with "valid" criteria. The percentage of the teacher's practicality results that fell into the "very practical" category was 90.1%, while the percentage of the student practicality results that fell into the same category was 82,0%. With the "very effective" category, the effectiveness test scored 87.8%. The resulting N-Gain value, which fell into the "medium" range, was 56.5%. Therefore, it is appropriate for use in learning activities since the STEAM-based E-LKPD teaching medium is sufficiently effective to enhance creative thinking abilities.

Keywords: creative thinking skills, STEAM approach, E-LKPD, geometry transformations, secondary school

Abstrak

Di era informasi dan persaingan yang semakin ketat, kemampuan berpikir kreatif dalam matematika dan mata pelajaran lainnya merupakan keterampilan hidup yang sangat berharga. Rendahnya kemampuan siswa dalam berpikir kreatif merupakan hasil dari strategi dan proses pembelajaran yang kurang optimal. Pembelajaran STEAM muncul sebagai upaya untuk mengatasi kekurangan metode pembelajaran sebelumnya. Dengan membuat bahan ajar berupa E-LKPD (Lembar Kerja Peserta Didik) berbasis STEAM (Science, Technology, Engineering, Arts, and Mathematics), penelitian ini berupaya untuk meningkatkan kemampuan berpikir kreatif peserta didik. E-LKPD berbasis STEAM ini dirancang dengan menggunakan *Liveworksheet*. Metode yang digunakan dalam penelitian ini adalah metode ADDIE (Analysis, Design, Development, Implementation, Evaluation). Uji coba dilakukan di salah satu SMP di Kota Jambi dengan mengambil salah satu kelas IX di sekolah tersebut dengan jumlah peserta didik sebanyak 28 orang. Analisis data diukur dengan menggunakan skala Likert, kemudian hasil tes kemampuan berpikir kreatif dihitung dengan menggunakan rumus N-Gain. Hasil penelitian menunjukkan bahwa LKPD berbasis STEAM memenuhi kriteria kualitas produk yang meliputi kevalidan, kepraktisan, dan keefektifan. Hasil penelitian menunjukkan bahwa validitas desain mencapai persentase 91,4% dengan kriteria "sangat valid", sedangkan persentase validitas materi sebesar 80% dengan kriteria "valid". Persentase hasil kepraktisan guru yang masuk dalam kategori "sangat praktis" sebesar 90,1%, sedangkan persentase hasil kepraktisan siswa yang masuk dalam kategori yang sama sebesar 82,0%. Dengan kategori "sangat efektif", uji keefektifan memperoleh nilai 87,8%. Nilai N-Gain yang dihasilkan masuk dalam rentang "sedang" yaitu 56,5%. Oleh karena itu, LKPD berbasis STEAM layak digunakan dalam kegiatan pembelajaran karena LKPD berbasis STEAM cukup efektif untuk meningkatkan kemampuan berpikir kreatif.

Kata kunci: kemampuan berpikir kreatif, pendekatan STEAM, E-LKPD, transformasi geometri, sekolah menengah

Received: June 5, 2025; Revised: June 15, 2025; Accepted: June 24, 2025

INTRODUCTION

The world of education has been greatly influenced by rapid advances in information and communication technology. Education today is evolving at a rapid pace in the knowledge age. Significant changes are occurring in the 21st century, particularly in the field of education. Teachers need to be creative in their teaching methods because there is a great need for human resources (Hasibuan & Prastowo, 2019). With an expanding role in the era of globalization, teachers with character are needed because science and technology are developing rapidly and sophisticatedly. Schools must have 4C skills, namely creative thinking, critical thinking, communicating, and collaborating (Septikasari & Frasandy, 2018). There is a correlation between mathematical creativity and mathematical creativity (Rozi & Afriansyah, 2022). Mathematical creative thinking ability is the capacity to solve a problem by applying thought processes grounded in logical concepts and principles (Soeviatulfitri & Kashardi, 2020). Mathematical creative thinking ability is the capacity to solve mathematical problems having several solutions (Rahayu et al., 2019). Nonetheless, empirical evidence indicates that students' creative thinking abilities remain low, as demonstrated by Suparman & Zanthy (2019) research. Students' mistakes in solving mathematical creative thinking ability questions, which involve creating mathematical models and determining whether the concepts and elements are sufficient, as well as mistakes made by students when completing arithmetic operations.

The Program for International Student Assessment (PISA) 2022 results show that Indonesia's PISA score in 2022 is lower than in 2018 (OECD, 2023), as shown in figure 1:

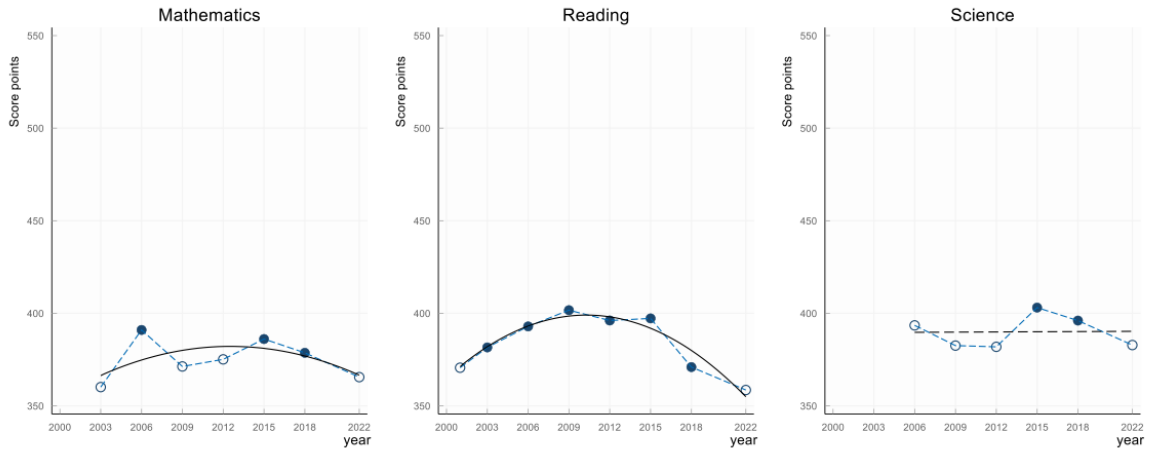

Figure 1 PISA Result 2022

According to the Organization for Economic Cooperation and Development's (OECD) 2022 PISA results, as seen in Figure 1 above, Indonesia has seen a shift in its PISA ranking, albeit not all of these changes have been positive. The alterations were that although Indonesia's ranking rose, pupils' average scores actually fell. In PISA 2022, Indonesian students' average math performance dropped to 366, a loss of 13.1 points from the previous year's 379. This decrease shows that although there was an improvement in the relative ranking compared to other countries, in absolute terms, the mathematical ability of Indonesian students actually decreased. This is concerning since one of the most important subjects for cultivating critical and creative thinking abilities is mathematics. Teachers must be able to make learning mathematics enjoyable and creative in addition to requiring pupils to possess critical and creative thinking abilities.

The findings of the mathematics teacher's interview with Class IX offer useful information about the classroom arithmetic learning process. The majority of the time, teachers still present the content using traditional techniques. In other words, the instructor explains the subject, provides examples of mathematical problems or problems with answers, and then administers tests. According to the learning paradigm, learning can only take place when teachers and pupils are present at the same time and location. Furthermore, the majority of pupils lacked full creative thinking abilities, according to the results of examinations given in class IX that evaluated students' creative thinking abilities using geometric transformation material.

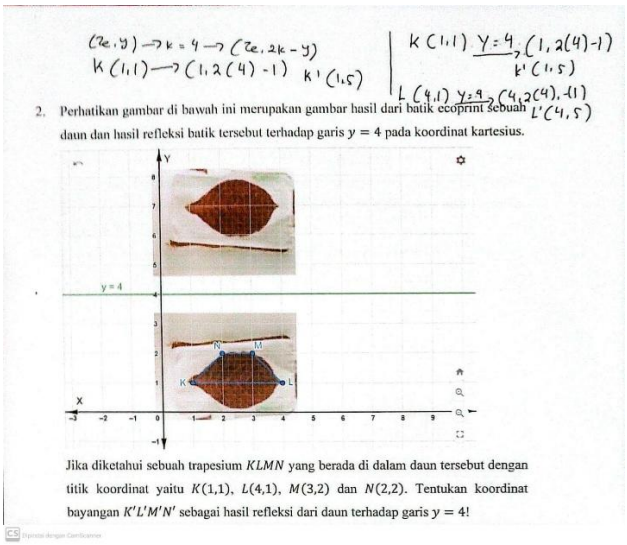

Figure 2 Student Test Answers

Figure 2 shows that the test answers do not meet the criteria for creative thinking skills such as fluency, flexibility, and originality. The fluency indicator shows that students have not been able to think fluently to generate multiple solutions to the given problem. The flexible indicator shows that students can only solve problems using algebraic methods, and there are still errors in calculations. The flexible indicator also shows that students cannot see the geometric solution from the given figure. In addition, the originality indicator shows that students cannot generate unique, new, or unusual ideas.

Some studies show that students often experience misconceptions and difficulties in understanding basic geometry concepts, such as determining the properties of flat and spatial shapes, visualizing geometry objects, and solving geometry problems. So geometry material is one of the materials that provide a lot of space to train and develop creativity. Given the importance of learning geometry, students in schools are not sufficiently equipped with an understanding of the concept alone but need to be trained how to apply the concept to solve the problem at hand. As a result, efforts must be made to raise pupils' proficiency and comprehension of geometry.

Numerous studies, including the Subakti et al. (2021) project that created E-LKPD with Jambi culture based on STEM, have attempted to enhance creative thinking abilities. The study exclusively employs the STEM approach, although taking cultural factors into account; no research has combined the STEAM approach with other cultures. Here, art and culture are strongly intertwined. The art component is one of the five elements that make up the STEAM approach component. In addition, there is still much software that can be used in developing an E-LKPD as teaching media to help students during the learning process in the classroom.

Students' ability to think creatively can be enhanced by learning resources, such as instructional materials that are customized to their requirements and traits. In addition to supporting general learning activities, using instructional materials as learning media in the mathematics classroom can help students' thinking, focus, and skills. Asking questions and challenging the material in the instructional materials are two ways that teachers can help students develop their creative thinking abilities.

The STEAM learning approach, which stands for Science, Technology, Engineering, Art, and Mathematics, is one of the teaching strategies that is in line with the traits of kids in the era of the fourth industrial revolution toward the era of society 5.0. Through the use of

problem-solving techniques that incorporate these five acronyms, this teaching approach fosters critical and creative thinking in pupils. The goal is for students to be able to use their own problem-solving methods (Handayani et al., 2023).

Geometry learning requires methods that can bring out the active role of students and creative thinking so that students have a better understanding. The STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning paradigm was developed in response to the times' ever-increasing complexity and fast-changing demands. Its goal is to equip young people with the necessary abilities to deal with the global changes brought about by scientific and technological advancements. In the 21st century, solutions to problems encountered in areas such as business, economics, and science increasingly rely on understanding and applying multidisciplinary concepts. STEAM aims to bring together the domains of art, technology, science, math, and engineering so that the learning environment becomes more contextualized and holistic.

In an effort to address the drawbacks of earlier teaching approaches that were overly teacher-focused, the STEAM learning model was developed. Most traditional curricula often separate subjects like art, music, and language from subjects like math and science. This can hinder the development of children's creativity and their ability to think broadly. For students to understand how art and science work together, STEAM aims to combine various disciplines (Nuragnia et al., 2021).

Furthermore, a worldwide labor market that is increasingly demanding STEM-based abilities (Science, Technology, Engineering, and Mathematics) gave rise to the STEAM learning approach. Today, many jobs require a deep understanding of technical concepts as well as the ability to think creatively and innovatively. A generation prepared to compete in an increasingly complicated workplace can be produced with the aid of STEAM (Hasanah et al., 2021).

One of the many changes brought about by the usage of technology in the classroom is the learning of media design. Despite the fact that learning is not conducted in a classroom setting, the use of digital media in mathematics education helps pupils comprehend abstract mathematical concepts. Digital learning can increase productivity and reduce the amount of time spent (Sarman et al., 2023). The development and improvement of telecommunication hardware such as smartphones and laptops also make learning easier. Therefore, this

increasingly sophisticated technological advancement must be used in education (Prastika & Masniladevi, 2021).

Liveworksheet is a website developed by Google that can convert conventional printable worksheets (document, PDF, and JPG) into interactive worksheets that can contain images, audio, and video. It is a very good learning medium (Widiyani & Pramudiani, 2021). *Liveworksheet* is a Google web-based interactive worksheet that has various displays, including images, videos, MP3s, and other interesting symbols.

One of the developments of Learner Worksheets (LKPD) is LKPD, which is managed based on electronic devices (E-LKPD) that utilize technological advances. E-LKPD (Electronic Learner Worksheet) is an exercise sheet that is done by students systematically and continuously within a predetermined time span through the use of digital devices. According to the above description, the goal of this study is to outline the quality and development process of STEAM-based E-LKPD in order to enhance students' capacity for creative thought when working with geometric transformation materials.

METHODS

Development research, sometimes referred to as R&D (Research and Development), is usually used to enhance an existing product or produce a new one. This development research used the ADDIE development approach, which stands for Analyze, Design, Development, Implementation, and Evaluation. This methodology comprises a set of methodically organized exercises designed to address learning challenges associated with educational materials and is tailored to the requirements and traits of learners. This methodology consists of five stages: analysis, design, development, implementation, and assessment. Two instrument experts who taught mathematics education at Jambi University served as the test subjects for this development study. After that, the math instructor and pupils at a Jambi City junior high school.

Both quantitative and qualitative data were employed in this study. The evaluation results completed by the teachers, students, and validators participating in this development research provide quantitative data. This quantitative data is derived from response surveys from individual, small group, and outdoor trials aimed at enhancing students' mathematics creative thinking abilities using geometric transformation materials. In addition, quantitative results are also obtained from the assessment of student learning outcomes to calculate the

percentage. Qualitative data obtained during the product validation stage, input, criticism, and comments from the expert team of material and design experts were used as a benchmark to revise the developed product.

A Likert scale is used to quantify quantitative data analysis. For the purposes of quantitative analysis, Sugiyono (2013) states that the Likert scale is used to gauge an individual's or a group's attitudes, opinions, and perceptions about research variables. The scoring scale is shown in table 1 as follows:

Table 1 Scoring Scale

Score	Category
5	Strongly Agree (SS)
4	Agree (S)
3	Hesitate (R)
2	Disagree (TS)
1	Strongly Disagree (STS)

Quantitative data obtained during the study was analyzed using a Likert scale and calculated using formula (1) as follows:

$$P = \frac{f}{N} \times 100 \quad (1)$$

Description:

P = Percentage of validity

f = Score of data collection results

N = Maximum Score

The percentage of instrument validity requirements shown in table 2 below can be interpreted as follows:

Table 2 Validity Criteria

Percentage	Criteria
$80\% < P \leq 100\%$	Very Valid
$60\% < P \leq 80\%$	Valid
$40\% < P \leq 60\%$	Less Valid
$20\% < P \leq 40\%$	Invalid
$0\% < P \leq 20\%$	Highly Invalid

(Hapsari & Zulherman, 2021)

Finding out how successful they are through assessments is the goal of evaluating student learning results. If the efficiency of the STEAM-based E-LKPD on geometry transformation material is less than the minimal requirements for good, it is considered effective. The learning outcomes test is also used to determine whether or not students'

abilities to think creatively about mathematics have improved. We must observe whether the students' mathematical creative thinking abilities improve in order to determine the success or failure of the E-LKPD. According to the scoring guidelines, this test can have a maximum score of 100.

Data derived by comparing the difference between the real gain score and the maximum gain score, or the highest score attained by students, is called N-Gain, or normalized gain. To find out if the students' mathematics creative thinking skills improved following the application of E-LKPD, the N-Gain % was computed using the mathematical creative thinking ability exam. The N-gain value can be calculated using formula (2) as follows:

$$N - Gain = \frac{Postest\ Score - Pretest\ Score}{Max\ Score - Pretest\ Score} \quad (2)$$

The N-Gain interpretation criteria are stated in the following table 3, namely:

Table 3 N-Gain Effectiveness Level Category

Percentage	Criteria
$-1{,}00 \leq g < 0{,}00$	Decline
$g = 0{,}00$	Stable
$0{,}00 < g \leq 0{,}30$	Low
$0{,}30 < g \leq 0{,}70$	Medium
$0{,}70 < g \leq 1{,}00$	High

(Arifin et al., 2020)

RESULTS AND DISCUSSION

One of Jambi City's junior high schools served as the site of this development study. The study's output, a STEAM-based E-LKPD, aims to enhance students' mathematical creativity through geometric transformation content created using *Liveworksheet's* assistance. The five steps of the ADDIE-type development model—analysis, design, development, implementation, and evaluation—are used in this work.

An examination of the performance gap based on issues that occurred at school—specifically, students' lack of creative thinking skills—was conducted during the analysis stage. This is known from conversations with math teachers and the findings of observations of pupils' capacity for creative thought. According to the information gathered, students did not participate in class because there were insufficient teaching resources and instructional strategies. Therefore, E-LKPD teaching materials based on STEAM will be created to enhance students' capacity for creative thought.

Product research planning is done during the design phase, beginning with storyboard creation and gathering the resources, texts, photos, and instructional videos that will be used

in STEAM-based E-LKPD products. This STEAM-based E-LKPD product is designed and created using the Microsoft Word application and then inserted into the *Liveworksheet* so that the E-LKPD can be equipped with learning videos, text, questions, and also projects that will be done by students in the learning process and can improve creative thinking skills.

Once the product has been conceived, go on to the next phase of development. At this point in the development process, the created design is transformed into the first STEAM-based E-LKPD product. The created storyboard serves as the foundation for product development. Following completion, a team of specialists, including material and design experts, conducts a product validity test to determine the viability of the STEAM-based E-LKPD product. After that, the E-LKPD is put through a practicality test that includes both one-on-one and small-group trials.

The final product, which underwent development throughout this project, is a STEAM-based E-LKPD to enhance creative thinking abilities on geometric transformation material. Starting with the cover, identification, instructions, table of contents, CP and TP, and STEAM learning components and stages utilized in the development of the E-LKPD, the results of the E-LKPD design are organized in a sequential manner.

The five STEAM components—science, technology, engineering, art, and mathematics—are the elements in dispute. The Observation Step is one of five STEAM learning phases that were utilized to prepare the E-LKPD. The steps are: New Idea, Innovation, Creation, and Value. The STEAM-based E-LKPD design, as depicted in the image below, produced the following outcome.

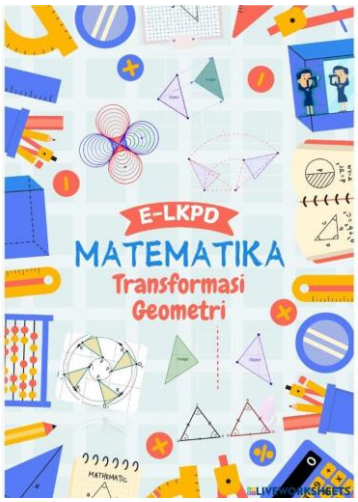

Figure 2 Cover

Figure 3 Identity

Figure 4 Table of Contents

Figure 5 E-LKPD Instructions

Figure 6 Working Instructions

Figure 7 CP and TP

Through a questionnaire, each professional validator offers a validation assessment along with feedback and ideas for enhancement. The following table 2 displays the findings of the material and design validations.

Table 4 E-LKPD Material Validation Results

Assessment Aspect	Assessment Score	Maximum Score	Percentage	Criteria
Content Feasibility	16	20	80%	Valid
Presentation Feasibility	16	20	80%	Valid
Language Feasibility	12	15	80%	Valid
Framework	32	40	80%	Valid
Average			**80%**	**Valid**

The results of material validation, which include an evaluation of the STEAM-based E-LKPD, are shown in table 4 above. The average percentage value of 80% with “valid” criteria indicates that the content in the STEAM-based E-LKPD has been deemed legitimate and appropriate for use in the classroom learning process. The STEAM-based E-LKPD's design has been deemed valid based on the findings of design validation, which include an assessment for the program. Table 5 shows an average percentage value of 91.4% with the qualification “very valid”.

Table 5 E-LKPD Design Validation Results

Assessment Aspect	Assessment Score	Maximum Score	Percentage	Criteria
Writing Display	20	20	100%	Very Valid
Design/Physical Appearance	33	35	94,3%	Very Valid
E-LKPD Framework	32	40	80%	Valid
Average			**91,4%**	**Very Valid**

The practicality test from the E-LKPD practicality questionnaire is used to evaluate the feasibility of E-LKPD in both small-group and one-on-one trials. The teacher's reaction to the STEAM-based E-LKPD product via the E-LKPD practicality boost is the one-on-one trial, also known as the individual trial.

Table 6 Teacher Practicality Test Results

Assessment Aspect	Assessment Score	Maximum Score	Percentage	Criteria
Comprehensive	13	15	86,7%	Very Practical
Suitability	22	25	88,0%	Very Practical
Use Of E-LKPD	43	45	95,6%	Very Practical
Average			**90,1%**	Very Practical

The practicality of STEAM-based E-LKPD is 90.1%, falling into the category of "very practical," according to the questionnaire findings shown in table 6 above. After that, it is possible to move on to the next phase of the STEAM-based E-LKPD. Additionally, nine pupils with varying skill levels participated in small group trials, namely 3 students with high ability, 3 students with medium ability, and 3 students with low ability selected by the math teacher in the class.

Table 7 Student Practicality Test Results

Assessment Aspect	Assessment Score	Maximum Score	Percentage	Criteria
Impact on Users	154	180	85,6%	Very Practical
Clarity of Learning	172	225	76,4%	Practical
Practicality	227	270	84,1%	Very Practical
Average			**82,0%**	Very Practical

The small group trial for the practicality of STEAM-based E-LKPD has an 82.0% practicality rate with the category "very practical," according to the questionnaire results in table 7 above. Accordingly, it is possible to use this STEAM-based E-LKPD for all student groups with varying skill levels in the classroom.

Furthermore, the implementation stage is carried out, given classroom learning using STEAM-based E-LKPD products that have passed the development stage. This E-LKPD product will be tested in a real research situation at school. This form of implementation is carried out during the field trial stage, which is limited to one class only. The purpose of this field trial was to determine the extent to which the STEAM-based E-LKPD has been developed in terms of effectiveness.

A large group trial was used to evaluate the efficacy of this E-LKPD in terms of student replies and the outcomes of the students' initial and final exams. The E-LKPD practicality

questionnaire was used to evaluate student responses in the large group trial, and the N-Gain value formula was used to compute the test results.

Table 8 Effectiveness Test Results (Student Response Questionnaire)

Assessment Aspect	Assessment Score	Maximum Score	Percentage	Criteria
Content and Objectives	617	700	88,1%	Very Effective
E-Lkpd Function	735	840	87,5%	Very Effective
Average			**87,8%**	**Very Effective**

Table 8 of the aforementioned student response questionnaire findings shows that students respond well to the STEAM-based E-LKPD employed in the learning process, with an effectiveness percentage of 87.8% falling into the “very valid” category. Consequently, it can be said that the STEAM-based E-LKPD to enhance students' mathematical creativity in relation to geometric transformation content satisfies the requisite standards. A summary of the findings from the computation of each student's N-Gain value is provided in table 9.

Table 9 Recapitulation of Student N-Gain Calculation Results

Student Code	Percentage	Criteria	Number of Students
S13, S16	$0{,}70 < g \leq 1{,}00$	High	2
S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S14, S15, S17, S18, S19, S20, S21, S22, S23, S24, S25, S26, S27, S28	$0{,}30 < g \leq 0{,}70$	Medium	26
Amount			**28**

From table 9 above, it can be seen that the percentage of N-Gain values obtained by students is at the “high” and “medium” criteria levels; there are no students who obtain the criteria for the percentage of N-Gain values “low,” “stable,” or “decreasing”. Of the 28 students in the class, there were only 2 students who obtained the percentage criteria for the N-Gain value at the “high” level, and the remaining 26 students obtained the percentage criteria for the N-Gain value at the “medium” level. The average N-Gain value derived from students' average beginning and final test scores is displayed in Table 10 below.

Table 10 Calculation Results of Average N-Gain Value

Average Score on the First Test	Average Score on the Final Test	Average of N-Gain Score	Criteria
34,46428571	**70,78571429**	**0,565103388**	**Medium**

According to the average N-Gain value calculated in table 4.10 above, pupils' capacity for mathematical creativity has grown. Students' mathematical creative thinking abilities improved by 0.565103388 based on the average N-Gain value calculation, placing them in the “medium” category of the N-Gain criteria level. Students' ability to think creatively has

improved both before and after utilizing the produced E-LKPD products, according to the findings of the N-Gain test. However, this progress has not reached the high category for the average N-Gain value of students, as only two students were able to obtain the N-Gain value in the high category. Therefore, this N-Gain number suggests that the E-LKPD product has been successful in enhancing students' capacity for original thought. This is also predicated on Akker et al. (2012) theory that learning aids are considered successful if students successfully complete the learning process and if the curriculum, learning process accomplishments, and students' learning experiences are consistent.

Additionally, the evaluation stage is a procedure that is carried out from the analysis stage, which is the first stage of research, to the implementation stage. Analysis, design, development, and implementation are always the phases at which evaluation is done. Through this review stage, products created in compliance with the preliminary analysis of research needs are reassessed. The evaluation results at the analysis stage demonstrated that the issues found aligned with the information gathered during the school observation phase. In order to create a design that is consistent with the analysis carried out, the assessment results during the design stage are presented as storyboard modifications. Following a number of enhancements, the assessment results at the development stage comprised an analysis of the data from the material and design validity questionnaires supplied by material experts and design experts. Additionally, the E-LKPD product will be used in classrooms so that students can use it for learning. To determine the quality of E-LKPD used throughout the learning process during school research, the assessment stage is conducted again after the deployment stage. Students' ability to think creatively has improved, according to the study that has been done overall.

The study's findings show a significant improvement in students' capacity for creative thought, proving that STEAM-based E-LKPD is adequate to foster creative thinking when it comes to geometric transformation content. This is consistent with the findings of a study conducted by Subakti et al. (2021), which also demonstrates that students' capacity for mathematical creativity has grown in the medium category. This suggests that the E-LKPD has effectively met its predetermined objectives. Furthermore, the results of the feasibility test, LKPD with a STEAM approach through the PjBL model, which aims to improve students'

creative thinking skills in class VIII circle material, meet the necessary criteria, according to research by Wening & Hayuhantika (2023).

CONCLUSION

According to the findings of this development research, class IX geometry transformation material can be improved through the use of instructional media in the form of STEAM-based E-LKPD. The steps of the ADDIE development paradigm are followed when creating STEAM-based E-LKPD to enhance students' capacity for creative thought when working with geometric transformation materials. Three eligibility criteria—valid, practical, and effective—are used to evaluate how well STEAM-based E-LKPD fosters creative thinking abilities.

From the results of the discussion, with the criterion of "valid," the percentage of material validity was found to be 80%, and with the criteria of "very valid," the percentage of design validity was found to be 91.4%. Following that, the practical criteria results from the individual test showed a 90.1% percentage with the category "very practical," and the small group trial showed an 82.0% percentage with the same category. Additionally, the effectiveness test yielded 87.8% of the effective criteria, falling into the "very effective" group. The E-LKPD produced can then enhance students' mathematical creative thinking skills by 56.5%, which falls under the "medium" group, according to the N-Gain value acquired. Based on these findings, it can be said that the STEAM-based E-LKPD for enhancing creative thinking abilities satisfies the requirements of being legitimate, useful, and efficient, making it appropriate for use in educational activities.

Teachers or aspiring teachers can use the implications of this development research's findings as a new innovation for high-quality teaching materials and incorporate them with STEAM to foster students' capacity for creative thought. The development of STEAM-based E-LKPD to enhance creative thinking skills on geometry transformation material can be combined with other mathematics learning resources that can be enhanced through the use of more inventive and creative models, techniques, and learning strategies to enhance other mathematical abilities and skills.

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