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Developing LKPD using the STEAM approach to facilitate the creative mathematical thinking ability of grade X students

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Abstract
This study is based on the observation that students struggle to think mathematically creatively when studying statistical material, and that there is currently no effective learning tool to help students develop this skill. The purpose of this research is to inform the creation of a STEAM-based statistics worksheet for use with students in class X SMA/MA, to foster their capacity for mathematical creativity. This research uses the 4D model, including Define, Design, Develop, and Disseminate. Data collection techniques included observations and interviews. This study involved students from Class X at SMAN 2 Siak Hulu. The results indicate that LKPD is valid, based on expert review, and practical, as demonstrated by the field test. At the field trial stage, the LKPD developed meets the assessment aspects: ease of use, presentation, readability, and time. So, the STEAM-based LKPD can be used during learning to facilitate creative mathematical thinking abilities.

Keywords: mathematical creative thinking, LKPD, STEAM

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I. Introduction

The 21st century requires every individual to have skills or abilities, be able to collaborate, have critical and creative thinking patterns, have innovative learning skills, and be skilled in using technology and information (Kumari & Yagnik, 2025). A person does not possess these skills since birth but through various processes of practice, learning, and experience (Yanuarni, Yuanita, & Maimunah, 2021) The capacity to think mathematically creatively entails coming up with and accurately applying novel, distinct, and original ideas or concepts in order to solve mathematical issues (Putra, Akhdiyat, Setiany & Andiarani, 2018).

Creative thinking skills in mathematics are needed to empower students' creative thinking, which aims to provide students with the breadth to make choices in solving problems related to mathematics (Pangestu & Yunianta, 2019; Afriansyah, 2021; Agustina & Sumartini, 2021). The four indicators of creative thinking skills that can give rise to creative attitudes are: (1) Fluency, which is generating many ideas or concepts in solving mathematical problems; (2) Flexibility, which is solving mathematical problems by providing various solutions correctly; (3) Originality, which is coming up with fresh ideas for solving mathematical difficulties using one's own thoughts; 4) Elaboration, which is providing systematic and detailed solutions or answers (Putra et al., 2018; Sari & Untarti, 2021).

The truth is that many pupils in different schools still have less-than-stellar abilities when it comes to mathematical creativity. A research of creative thinking skills was conducted in 2024 as part of the PISA, Indonesia has very low talent in terms of creativity and creative reasoning; only 1% of students with the highest scores in creative thinking are also students with the highest scores in mathematics (OECD, 2024). According to Santi et al. (2019), the average percentage of all indicators was 42%, indicating that vocational high school students in Pekanbaru City still have relatively low mathematical creative thinking skills. Wardani & Suripah (2023) also found that 29% of high school students had limited mathematics creative thinking ability, indicating that this skill is still prevalent among kids. In line with the results of Telaumbanua (2022), findings from studies examining the mathematical creativity of high school students reveal that this demographic's mathematical creativity remains below average.

Therefore, current mathematics learning requires innovation. Achieving this innovation requires student creativity. A lack of creative abilities in mathematics learning will impact the development of students' mathematical creative thinking skills (Alsafran, Awad, Rabiah & ALmansour, 2025). In order to get better at solving mathematical problems, students need to regularly practice their creative thinking skills (Tadjamawo, Kaunang, & Tilaar, 2024)

There needs to be innovation in student-centered learning and learning that provides opportunities for students to improve their learning activities. One form of preparation that teachers must do in the learning process is to prepare learning tools, one of which is LKPD (Putri, Roza & Maimunah, 2020). LKPD is a teaching material that helps students find and integrate various concepts that have been discovered. For this reason, learning with the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach is here to facilitate the development of 21st-century skills for students, including the ability to think creatively in mathematics. According to Wibawa (2024), in STEAM-based learning, students, instructors, and learning resources work together to address real-world problems and foster critical thinking via the application of knowledge in science, technology, engineering, art, and mathematics. By bringing together the five branches of science, we can better equip our students to think outside the box when faced with challenges in their coursework (Oktafiany, Irwandi & Sakroni, 2022). According to Priyatno (2023), enhancing mathematical creative problem-solving abilities is a potential outcome of implementing STEAM-based learning. The goal of creating LKPD is to let students practice solving mathematical issues in real-world contexts, and it is believed that this will be a viable solution (Izzati & Dwinata, 2019).

Based on research conducted by Fitria, Dwijanto, & Dewi (2023), results show that mathematics creative thinking skills are significantly improved when the PBL paradigm is combined with a STEAM approach to learning. According to Chairunnissa, Anriani, & Santosa (2022), after introducing a STEAM approach to learning in an 8th-grade junior high school, researchers observed a change in students' creative thinking abilities. Those with high levels of creativity could show signs of fluency, flexibility, and elaboration, while those with medium or low levels of creativity could already show signs of fluency. In addition, according to Rizal et al. (2025), the implementation of the STEAM approach in the PBL model for elementary school students was found to improve students' learning outcomes and enhance their creativity in finding solutions. However, the three studies explained that students with low cognitive abilities tend to show only limited progress and have a lack of participation in learning.

Teaching materials are needed to overcome these difficulties, namely, LKPD based on the STEAM approach. This study focuses on developing LKPD based on the STEAM approach to facilitate the mathematical creative thinking skills of grade X SMA/MA students.

II. Research Method

This 4D development model created by Thiagarajan is discussed in this paper. This model comprises four distinct phases: define, design, develop, and disseminate (Natasya & Izzati, 2020).

Gathering references or reading materials, analyzing tasks and concepts, analyzing students, defining learning objectives, and conducting initial and final analyses are all part of the define stage. The classroom scene, students' mathematical creativity, and the instructional resources utilized were the subjects of the cloud-final analysis. The analysis of students aims to determine the characteristics of SMAN 2 Siak Hulu students, including their level of thinking and mathematical creative thinking abilities, which are used as a reference for designing LKPD to be developed. Task analysis with statistical material referring to CP Mathematics Phase E. Concept analysis by dividing sub-material into five meetings with a time allocation adjusted to SMAN 2 Siak Hulu Class X. Furthermore, the learning objectives by determining the learning objectives achieved with the statistics sub-material. Then, I will collect references and reading materials related to statistics.

The design stage compiles validity and practicality criteria tests, selects the LKPD format, selects supporting media, and creates an initial product design, the LKPD draft. This design stage produces an LKPD draft that has been adjusted to the class X statistics material.

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The development stage is carried out by formative evaluation from Tessmer, 1993 with the following stages: (a) self-evaluation; at this stage, the LKPD draft will be redesigned and evaluated along with the revision of the research, the design results obtained are called draft I; (b) expert review, draft I am given to 3 validators to evaluate and assess draft I, one-to-one draft I is given to three students with heterogeneous abilities and not research subjects for readability testing, the results of expert review and one-to-one improvements are called draft II. Furthermore, a small group of 6 students was selected for a trial of draft II, and the results of the improvements are presented in draft III. Then a field test was conducted for trials in 3 classes at SMAN 2 Siak Hulu with heterogeneous abilities to assess the practicality of the LKPD, and the results of the field test produced the final product.

The selection of SMAN 2 Siak Hulu as the research location was not done randomly, but rather through a purposive sampling technique. This school was chosen based on careful consideration that its characteristics could represent the population of senior high schools/Islamic senior high schools (SMA/MA) in general in Pekanbaru City. The considerations include: (1) accreditation level: SMAN 2 Siak Hulu has an A accreditation, which is the most common accreditation level and is held by many schools in Pekanbaru. This indicates that the management standards, infrastructure, and quality of educators are at a level that represents the majority; (2) student characteristics: the backgrounds and academic abilities of students at SMAN 2 Siak Hulu are very heterogeneous; this diversity reflects the general condition of students in other schools, so the student worksheets (LKPD) developed are expected to be suitable for various levels of student ability; (3) curriculum and learning process: SMAN 2 Siak Hulu has fully implemented the Merdeka Curriculum, just like the majority of other schools in Indonesia. The ongoing learning process also follows the applicable standards, so the use of LKPD in this study occurs in a natural and genuine learning context; (4) support from the school, the principal, and mathematics subject teachers showed openness and support for this research activity, thereby ensuring the smooth collection of valid data.

The results of this study are based on primary data collected from students' practicality sheets throughout the small group and field test phases, as well as from the validation sheets of each LKPD validator. A questionnaire, a non-test technique, was utilized to gather data in this investigation. The questionnaire used is the LKPD validation questionnaire and the LKPD practicality assessment. This questionnaire uses a Likert scale that includes: (1) very inappropriate; (2) not appropriate; (3) appropriate; (4) very appropriate.

Table 1. Validity assessment indicators

Assessment Aspects	Assessment Indicators
Face Validity	• LKPD cover display • Supporting elements for LKPD presentation • Appropriateness of images used in LKPD • Appropriateness of text in LKPD
Content Validity	• Suitability of the material with CP, ATP, and TP • Accuracy of the material • Up-to-dateness of the material • Encouraging student participation • Suitability of the material with the students' level of thinking
Construct Validity	• The suitability of the LKPD with the STEAM approach • The suitability of the activities in the LKPD with the Indicators of Mathematical Creative • Thinking ability: Attracting students' attention to learn • Clarity of presentation • Accuracy in the use of language

Table 2. Practicality assessment indicators

Assessment Aspects	Assessment Indicators
Ease of Using LKPD	• Clarity of the writing or text on the LKPD so that it can be read • Appropriateness of the composition of color, size, and placement of images on the LKPD • Appearance of images on the LKPD that is not blurry • Appropriateness of the LKPD filling space that is not blurry
Presentation of LKPD	• The appropriateness of material presentation with the STEAM steps • The suitability of content/material with indicators or the KBKM student steps • The presentation of the material stimulates students' interest in learning • The activities in the LKPD help in understanding the Statistics material
Readability	• The use of language in the LKPD so that it can be understood • Clarity of instructions/guidelines in the LKPD so that they are followed properly • The space provided is sufficient to answer the questions presented
Time	• The use of LKPD can be adjusted to the students' learning pace • The completion of LKPD has an appropriate time allocation

In the dissemination stage, after the final LKPD product gets consistent results and expert assessment produces positive comments, the LKPD can be distributed on a large scale.

This study utilized the LKPD validity tool for data collection. To find out if the LKPD that was designed is valid, validation is done. The LKPD validation sheet contains an assessment of face, content, and construct validity. Validation is carried out on three validators. The validation results from the validators on all assessed aspects are presented in a table form. To determine the average value of the validator, the researcher uses data analysis (Akbar, 2013) with the following formula:

$$V_a = \frac{T_{se}}{T_{sh}} \times 100\%$$

Description:
Va: Percentage of validity
Tse: Total score obtained from the validator
Tsh: Total maximum expected score

The values obtained are then interpreted in relation to the validity categories in the table below to determine the extent of the validity level of the LKPD developed.

Table 3. Validity level categories

Interval	Category
$85\% \leq V_a \leq 100\%$	Very Valid
$70\% \leq V_a < 85\%$	Valid
$50\% \leq V_a < 70\%$	Less Valid
$0\% < V_a < 50\%$	Not Valid

Source: (Akbar, 2013)

Data on the practicality of learning devices from student response questionnaires. Student response data was analyzed to assess the practicality of learning devices (Fitri, Yuanita, & Maimunah, 2020). The formula for calculating the average student assessment of the LKPD used according to (Akbar, 2013) is:

$$V_p = \frac{T_{se}}{T_{sh}} \times 100\%$$

Description:
VP: Percentage of practicality
Tse: Total empirical score from observers
Tsh: Total maximum expected score

The values obtained are then interpreted with the practicality category in the table below to determine the extent of the developed LKPD's practicality level.

Table 4. Category of the level of practicality of LKPD

Interval	Category
$85\% \leq V_p \leq 100\%$	Very Practical
$70\% \leq V_p < 85\%$	Practical
$50\% \leq V_p < 70\%$	Less Practical
$0\% < V_p < 50\%$	Not Practical

Source: (Akbar, 2013)

III. Results and Discussion

The purpose of this research is to help students in grade X SMA/MA enhance their mathematical creativity by creating an LKPD based on the STEAM approach. The definition stage is the first in the development of an LKPD. The difficulties that require solving are intended to be identified during the definition stage of this investigation (Anggaraini, Suanto & Yuanita, 2024). Teachers rarely employ LKPD in the learning process; students are more passive, and the findings from the define stage show that teachers use typical learning techniques. Additionally, when it comes to contextual maths issues, particularly those involving statistics, students' abilities remain relatively low. Students necessitate instructional strategies that facilitate content comprehension and problem solving in mathematics; LKPD is one such strategy. According to Astuti (2021), the printed teaching materials, known as LKPD or Student Worksheets, make it easier for students to understand the topic. Because LKPD includes activities focused on the students, it may encourage them to take an active role in their own learning. Also, by building LKPD on top of the STEAM framework, this study makes use of the STEAM approach. According to Wibawa (2024), by bringing together knowledge from the STEM (science, technology, engineering, art, and mathematics) disciplines, as well as the arts and mathematics, STEAM-based learning encourages students to think critically and creatively about real-world problems and how to find solutions (Oktafiany et al., 2022). As a result, a STEAM-based LKPD was created to help students strengthen their mathematics creative thinking abilities through the use of statistics-based content. Students' mathematical creativity is greatly enhanced by LKPD, which is based on the STEAM method (Haifaturrahmah, Hidayatullah, Maryani, Nurmiwati, & Azizah, 2020).

During the design phase, you will create the LKPD or draft, select the media, and prepare the test criteria. The LKPD draft consists of LKPD elements, namely: (1) title; (2) learning objectives that students must achieve; (3) learning instructions; (4) supporting information; (5) work

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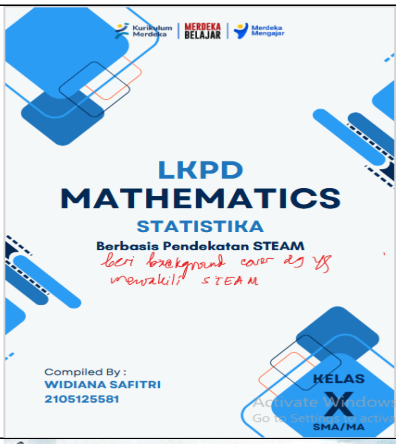
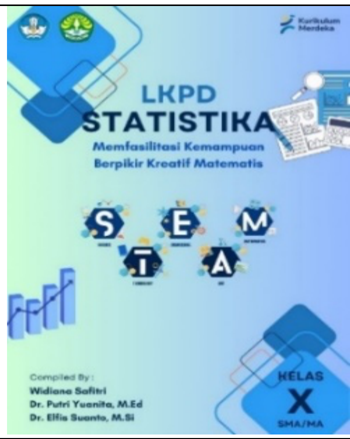
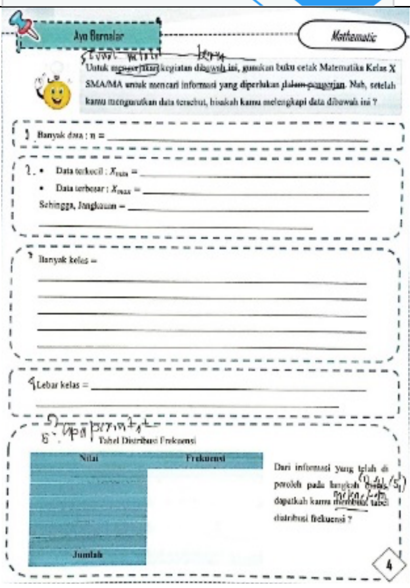
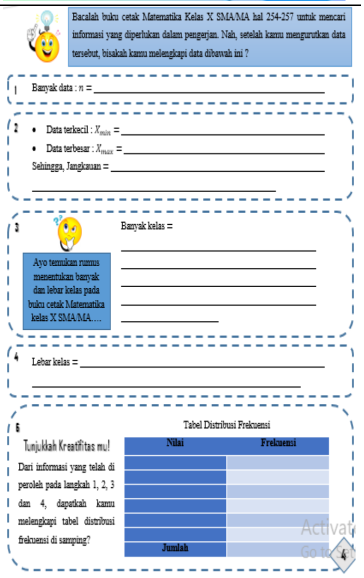
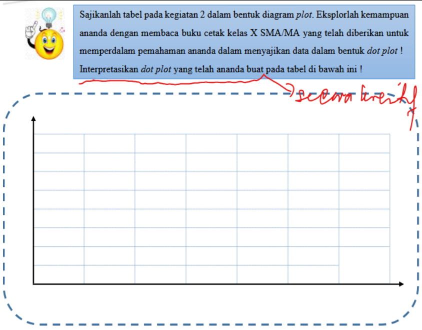
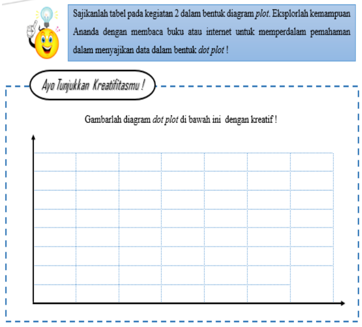
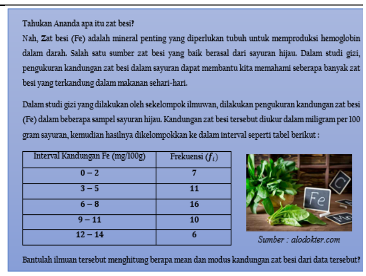
steps; (6) tasks to be completed; and (7) assessment. The LKPD draft is made with printed media in a format that is not much different from the LKPD used in schools. Learning activities in the LKPD draft refer to the five characteristics of the STEAM approach. Each characteristic of the STEAM approach aims to facilitate students' creative thinking skills. One form of preparation that teachers must do in the learning process is to prepare learning tools (Putri et al., 2020). The learning tools chosen in this study were LKPD with an initial design called draft I LKPD.

The next stage is development, which involves validation from experts and trials on students to see the practicality of STEAM-based LKPD (Perdana & Ramadhona, 2021). Researchers not only focus on asking for an assessment of the LKPD that is developed, but also ask for input and suggestions from validators to be used as considerations for developing the LKPD. Some validator input is seen in Table 3.

Table 3. Input from validator

No	Input Validator	Before Revision	After Revision
1	The validator suggested that the cover be given a background that illustrates the STEAM approach.		
2	In LKPD-1, the validator suggests including the book page in the command that tells students to read, then the validator also suggests that each step that students work on be made in the form of a number, so as not to write the word "above".		

<table>
<tr><th>No</th><th>Input Validator</th><th>Before Revision</th><th>After Revision</th></tr>
<tr><td>3</td><td>In LKPD-2, the validator suggests adding an invitation for students to think creatively at each step.</td><td>
</td><td>
</td></tr>
<tr><td>4</td><td>In LKPD-3, the validator suggests listing the source for each image used.</td><td>
</td><td>
</td></tr>
</table>

After providing input and suggestions on the LKPD, the validator is then asked to assess the LKPD that has been developed to see its feasibility. See Table 4 for the LKPD validation evaluation results.

Table 4. Expert validation results

No	Aspect	Average (%)
1	Face Validity	88,75%
2	Content Validity	94,36%
3	Construct Validity	90,19%
Overall Average		90,19%
Criteria		Very Valid

The findings of the validity test, conducted by three validators, met the very high criteria for validity. The validation performed by the validator aims to obtain criticism and suggestions so that the LKPD developed by the researcher can be improved. It becomes a quality LKPD and is suitable for learning (Kusria & Deswita, 2020). Along with the validity test, one-to-one interviews were also carried out on three students with heterogeneous ability levels to determine the readability of the LKPD and student reactions when working on the LKPD, which will be used as a reference for improving the LKPD. The revised results of the validity test and one-to-one are referred to as Draft II.

Next, a small group was conducted to test the practicality of the LKPD, which included aspects of ease of use, presentation, readability, and time, by providing a practicality questionnaire sheet. The practicality questionnaire was given to 6 students to find out their responses to draft II. Furthermore, revisions were made again to produce draft III. You may find the LKPD practicality test results in Table 5.

Table 5. Results of the LKPD practicality test in small groups.

No	Aspect	Average (%)
1	Ease of use LKPD	89,16%
2	LKPD presentation	88,24%
3	Readability	91,67%
4	Time	91,67%
Overall Average		90,18%
Criteria		Very Practical

Table 5 shows that the created LKPD was determined to be very practical based on the results of the practicality test on small groups. In addition, we will administer a field test/extensive group test to three similar groups. The purpose of this pilot project was to test the viability of implementing LKPD into STEAM-based statistics lessons for SMA/MA students in Grade X. As shown in Table 6, the LKPD practicality test was conducted with large groups.

Table 6. Results of the LKPD practicality test on large groups.

No	Aspect	Average (%)
1	Ease of use LKPD	87,94%
2	LKPD presentation	89,28%
3	Readability	91,23%
4	Time	91,76%
Overall Average		90,05%
Criteria		Very Practical

Table 6 shows the results of the practicality test on the big group. The produced LKPD was determined to be very practical, with a percentage of 90.05 percent. The purpose of this practicality testing was to evaluate the readability of the LKPD (Harapit & Hutapea, 2022).

This research reveals that students involved in STEAM-based learning are more capable of identifying problems, analyzing relevant information, and finding creative and logical solutions. Thus, the implementation of the STEAM approach in high school students not only enhances their learning outcomes but also strengthens their ability to solve problems effectively. This aligns with Rizal et al. (2025), who argue that this method does more than aid in grasping abstract ideas; it also pushes pupils to cultivate the analytical and imaginative capacities necessary to tackle the problems of the modern world. Furthermore, according to Dhitasarifa & Wusqo (2024), the application of STEAM teaching materials has a positive impact on improving problem-solving skills in a more creative manner and encourages students to participate more actively in problem-solving.

The dissemination stage consists of 2 activities: product packaging and product distribution to users by submitting LKPD to SMAN 2 Siak Hulu school. The following displays the LKPD packaging cover design based on the STEAM approach to Statistics material to facilitate students' mathematical creative thinking skills.

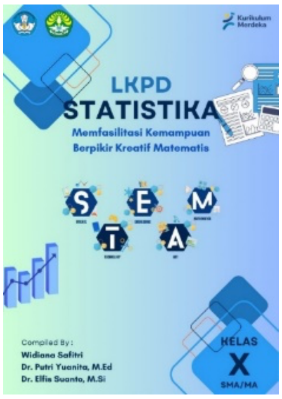


Figure 1. Appearance of the LKPD packaging cover

IV. Conclusion

The STEAM (science, technology, engineering, art, and mathematics) pedagogical framework emphasizes the interconnected nature of these fields as they relate to problem-solving. Students are encouraged to explore and utilize their particular skill sets through the STEAM learning approach. The focus of STEAM-based learning is integration, combining and making connections between various subjects.

To help students in grade X SMA/MA enhance their mathematical creativity, this development research creates LKPD based on the STEAM approach to statistics content. With an average validity of 90.19% and very valid criteria, and an average practicality of 90.05% and efficient criteria, LKPD, which is based on the STEAM approach to facilitating students' mathematical creative thinking skills, has met the valid and practical criteria.

There are several benefits and drawbacks to using LKPD in conjunction with the STEAM approach to help students develop mathematical creativity in their analysis of grade X SMA/MA statistics content, according to the findings of the development and trial runs. Among these advantages is the STEAM learning methodology, which incorporates, among other things, the mapping of mathematical and creative thinking components. Student activities utilizing LKPD with the STEAM approach demonstrate aspects of creative thinking. This approach is organized around a single theme, which includes creating unique problems through contextual science, fostering collaboration through work steps, making mathematics enjoyable through the arts, and increasing enthusiasm for learning through technology. The weaknesses in implementing the STEAM approach are that STEAM learning requires teachers who have extensive knowledge in various STEAM disciplines, teacher preparation and appropriate curriculum development can be complex and time-consuming tasks, technology integration and STEAM project preparation can require additional resources such as technological devices, and assessing student achievement in STEAM-based learning can be more complex compared to conventional learning approaches

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