

HOW TO DEVELOP AN E-LKPD WITH A SCIENTIFIC APPROACH TO ACHIEVING STUDENTS' MATHEMATICAL COMMUNICATION ABILITIES?

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ABSTRACT

This research aims to look into the growth and effectiveness of E-LKPD on the mathematical communication skills of seventh-grade junior high school students. The design research development study was used. This study is divided into two parts: preliminary (preliminary study and design of E-LKPD) and formative evaluation (evaluation and revision). The research subjects included 49 SMP Negeri 3 Ngamprah's class VIII students. The research instrument had interview sheets, expert validation sheets, observation sheets, student response questionnaires, and five questions about mathematical communication skills. Lines and angles were used in this study as the material. Data processing techniques in the development process use the Likert Scale type of measurement scale to calculate the percentage of each indicator with the help of Canva and test the effectiveness of the E-LKPD using Inferential Statistics with the Wilcoxon test with the help of SPSS. According to the study's findings, the feasibility of LKPD is Eligible. The study's results also show that an E-LKPD influences students' mathematical communication abilities, indicating that the developed E-LKPD has effectiveness.

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1. INTRODUCTION

Mathematics is a crucial field in the advancement of science and technology. Mathematics is studied at nearly every level of education. This occurs because many disciplines require practical mathematical concepts or calculations to advance. The International Student Assessment Program is one way to show appreciation for mathematics (PISA). Even in 2022, PISA's main focus will be on the math test, with the addition of a creative thinking ability test (Almarashdi & Jarrah, 2022; Özaydin & Arslan, 2022). This demonstrates that mathematics has grown in importance, even becoming a global concern,

to the point where studies on mathematical problems have become an urgent and top priority in the development of learning, particularly in Indonesia.

The current challenge is that students must be able to assess a problem, determine the appropriate representation based on existing data, and then represent it in a mathematical model (Apsari et al., 2020; Putri & Zulkardi, 2018). Mathematical communication skills are the ability to provide rational reasons, change the shape of a situation into a simpler model, and describe mathematical ideas or ideas in the form of relevant descriptions.

Mathematical communication is useful for completing, exploring, and investigating mathematics, as well as a social activity for exchanging ideas, and opinions, and sharpening ideas to persuade others. Mathematical communication skills are critical for students to have when learning mathematics, both elementary and middle school students must have good communication skills (Hendriana et al., 2022). Mathematical communication is essential for students, according to several explanations. However, the facts show that students' communication skills remain relatively low. One of the causes of students' low mathematical communication skills is their inability to communicate mathematical ideas while learning mathematics.

The problems that arise at this time present new challenges for teachers and researchers to find the best solutions to achieve learning objectives. The challenge for mathematics teachers in particular is to provide engaging, effective, and efficient learning under the current conditions of distance learning (Barana et al., 2021; Dhawan, 2020; Haleem et al., 2022; Russo et al., 2021). However, in reality, distance learning or online learning is still not optimally carried out, as research by Suripah and Susanti (2022), shows that many students still struggle to understand learning material, students lack the motivation to learn, and students do not master learning well. Furthermore, problems with the internet network are common when learning online. This is a common stumbling block when not all students have adequate facilities to support online learning, and unstable internet networks affect the online learning environment (Chu, 2010; Eze et al., 2018; Pham et al., 2019).

Zoom meetings are a platform that is quite attractive to teachers for the teaching and learning process during online learning (Tsarapkina et al., 2020). This is because the Zoom application drains a large quota and when the signal is less stable, learning becomes ineffective and information becomes incomplete, so the Zoom application is preferred by the smallest percentage. This shows that online learning is not effective if it is not supported by adequate technological facilities and infrastructure (Ardiansyah et al., 2021; Chu, 2010; Dharma et al., 2017; Eze et al., 2018; Pham et al., 2019).

Based on the problems described above, online learning requires special attention to minimize the obstacles that arise in order to achieve learning objectives and improve mathematical communication skills. Conference applications such as Zoom will be more effective once they are supported by adequate facilities with good devices and signals, but the availability of student facilities has not been achieved for the most part, so some of these conference applications are still in demand. The platform is an effective online learning tool that does not require a strong signal and is easy to implement. E-learning is a platform that does not require a stable network. It is also shown that learning through Google Classroom e-learning has a positive impact on students' reasoning abilities (Ansong-Gyimah, 2020).

According to the preliminary studies conducted in this study, educators continue to use ready-to-use LKPD that only contain instructions and practice questions, making learning more passive. This demonstrates the importance of creating interesting, non-boring, and interactive worksheets. Other field findings indicate that other supporting applications should be designed as creatively as possible in order for students to find learning more interesting, not boring, and meaningful. Creating interactive Student Worksheets (E-LKPD) with the Canva application is one way to support interactive e-learning that does not require

internet signal stability. This application will convert the standard LKPD into audio-visual additions. The presence of audio tools in the E-LKPD will aid comprehension of each instruction in the module. Video tools will be able to present contextual problems in a more interesting, real, and optimal manner. Several studies show that using audio-visual learning media improves learning outcomes and results in higher achievement than those who do not use audio-visual (Apriyanto et al., 2019; Rachmavita, 2020).

E-LKPD development must be accompanied by a learning approach that is relevant to the current curriculum, relevant to the material to be studied, and expected to improve mathematical communication skills. The scientific approach is one suitable approach for overcoming the various problems described earlier. The scientific approach makes learning more active by asking questions, making it less boring, and training students to communicate conclusions (Hendriana et al., 2017; Hendriana et al., 2018; Muttaqin et al., 2017; Nicol, 1998; Shahrill, 2013). Students can observe various problems in the E-LKPD, which can be packaged in a variety of formats, including not only text but contexts that appear more real, such as by inserting a video link. It is hoped that with these features, it will be able to attract students' attention and actively ask questions, as well as try to reason well so that they can construct and conclude mathematical concepts.

Several scientific studies on E-LKPD have been conducted. Research by Ulfah et al. (2020), researching on preliminary research of mathematics learning device development based on realistic mathematics education (RME). Previous research has found no specific development of interactive electronic worksheets based on a scientific approach and testing their effectiveness in improving mathematical communication skills. As a result, researchers are interested in conducting research on developing E-LKPD using a scientific approach and the Canva application and examining how effective it is in improving students' mathematical communication skills.

2. METHOD

This study is a research of development research, design research, or development studies. The subjects of this study were SMP Negeri 2 Cimahi class IX students. The Canva-assisted math Student Worksheets (LKPD) using a scientific approach to material outlines and angles are the subject of this development research. According to Tessmer (Hidayat et al., 2022; Kurniawan et al., 2018), there are two stages: preliminary research and formative evaluation. The preliminary study stage includes an analysis stage (student analysis, curriculum, and teaching materials), a design stage (prototyping), and a formative evaluation stage that includes self-evaluation, prototyping (expert review, one-to-one or small group), and field testing.

2.1. Preliminary Design

The researcher organized the location, subject, and other preparations, including the research schedule, at this point. The participants in this study were 49 students from SMPN 3 Ngamprah's classes VIII and VII. With an adjusted time allocation for learning mathematics for the 2021/2022 school year. The research subjects included three students for the individual test in class VIII, ten students for the group test in class VIII, and 36 students for the pilot test in class VII at SMP Negeri 3 Ngamprah.

2.2. Formative Evaluation Design

This stage is divided into three sub-stages: self-evaluation, prototype design, and field testing.

2.2.1. Self-Evaluation

This stage is split into two categories: analysis and design. The analysis phase aims to examine the discrepancy between learning objectives and learning outcomes, evaluate the curriculum to determine core competencies and fundamental competencies as a basis for deciding learning objectives that will be accumulated in the form of teaching materials to be designed, and analyze the curriculum to assess core competencies and basic competencies.

The researcher used a scientific approach to design a teaching material product in the form of a Canva-assisted electronic worksheet (E-LKPD) to improve students' mathematical communication skills on lines and angles during the design stage. The E-LKPD design is based on five aspects of feasibility (see [Table 1](#)): (1) material/content; (2) presentation; (3) language; (4) scientific approach suitability; (5) graphics

Table 1. Indicators of development aspects of E-LKPD

No	Aspects of Development	Indicator
1	Content / Material	<ul style="list-style-type: none"> a. compliance with the learning objectives b. compatibility with student characteristics c. The framework of the materials
2	Presentation	<ul style="list-style-type: none"> a. The topical relevance of the picture examples b. Appropriateness of layout settings c. Appropriateness of letter type and size
3	Language	<ul style="list-style-type: none"> a. Communicative and interactive b. compliance with good and correct Indonesian rules c. Compatibility of sentences with students' thinking levels
4	In accordance with the scientific approach	<ul style="list-style-type: none"> a. Construction ideas b. According to the scientific approach's characteristics
5	Technical compliance	<ul style="list-style-type: none"> a. Representative b. It can be used without any other media. c. Convenient to be using

2.2.2. Designing the Prototype

This stage has three stages: expert review, one-on-one, or small group. At this stage, the developed E-LKPD must be tested, reviewed, and evaluated.

Expert Review

Validation is carried out at this stage by material and media experts who analyze the strengths and weaknesses and comprehensively assess and evaluate them. Expert validation

is performed to obtain an assessment of the teaching materials that are being developed, with the hope that the teaching materials will be suitable for testing.

Researchers have created an initial design for the developed LKPD. At the formative revision stage, the draft receives input from material and media experts, as well as practitioners, and this becomes material for consideration in the LKPD development process before the LKPD is implemented.

One-on-One Test

At this stage, errors in planning and learning resources should be avoided, and an initial reaction from student stakeholders should be obtained. Three students with good, medium, and poor criteria who had studied lines and angles material were selected.

Small-group experiment

The goal at this stage is to determine the practicability of the E-LKPD that has been developed after being revised by the validator. Students who have studied lines and angles will participate in this stage. At this stage, there were as many as ten respondents from class VIII SMP Negeri 3 Ngamprah. Students in this stage are asked to observe the development of the E-LKPD, and then they are given a questionnaire to assess the E-practicability. LKPDs The collected data is then summarized and used to revise the developed E-LKPD so that it can be processed and re-tested at a later stage to produce an effective E-LKPD.

2.2.3. Field Tryout

Formative evaluation concludes with field trials. The goal of field trials is to determine whether learning can take place in a given context. The results of the field trials will be used to determine whether learning is appropriate and effective to implement. The test was conducted on a larger number of students than the small group test, namely 36 class VII students from SMPN 3 Ngamprah.

The validity and practicability of LKPD, as well as its effectiveness in use, were tested through data analysis. The first stage evaluated the product's validity. According to Hidayat et al. (2023), the following formula is used to calculate the validation results from the validator.

$$V = \frac{f}{n} \times 100\%$$

The details:

- V : The final score
- f : Score obtained
- n : Maximum score

The obtained results are interpreted by the product validity level criteria (see [Table 2](#)).

Table 2. Product validity criteria

Grade (%)	Category
81 - 100	Precise
61 - 80	Valid
41 - 60	Adequately Valid
21 - 40	Invalid
< 21	Null

A Likert scale is used in the second stage of the practicality test. The form of each statement is scored, and the total score of each student's answer is calculated. The value of the questionnaire data was assessed using the formula (Mustami et al., 2019).

$$P = \frac{(\sum f)}{N} \times 100\%$$

The details:

P : The final score

$\sum f$: Sum score

N : Maximum score

After determining the final value of practicability, examine the criteria (see [Table 3](#)).

Table 3. Criteria for practicality

Grade (%)	Category
$80\% < P \leq 100\%$	Highly practical
$60\% < P \leq 80\%$	Practical
$40\% < P \leq 60\%$	Quite practical
$20\% < P \leq 40\%$	Less practical
$P \leq 20\%$	Impractical

The third stage of testing the effectiveness of LKPD involves using SPSS Software to examine the normality and difference between the two Wilcoxon averages. Because the data were not normally distributed, the Wilcoxon test was used. The Wilcoxon test compares the means of two paired samples to see if there is a difference.

3. RESULT AND DISCUSSION

3.1. Preliminary

The first step is to conduct a preliminary study to determine what is causing the disparity between learning objectives and learning outcomes. In this step, the researcher gathered data by conducting interviews with one of the mathematics teachers. The information gleaned from the interviews is then entered into the performance appraisal. Performance evaluation reveals the reasons or causes of learning performance gaps. This performance evaluation includes the field learning process, the desired learning process, and the main causes of learning performance gaps. In addition, there is a performance evaluation as follows (see [Table 4](#)).

Table 4. Preliminary research

The Actual Situation	Ideal Objectives	The Primary Cause
The use of LKPD in schools when learning is still simple and relies relying on government learning resources	The application of LKPD with modern technology.	Lack of teacher interest in using other media, limited time, and inadequate training
The lecture and question and answer methods are still used in the learning process, which is centred on the teacher.	Student-centred education	Inadequate learning resources and facilities, overcrowded classes, and a concentration on pursuing material
Students are less able to construct mathematical ideas into images and graphics due to a lack of understanding of the material, one of which is lines and angles.	Students can construct mathematical ideas into pictures and graphs by understanding the material of lines and angles.	Limited student ability to translate mathematical concepts into images and graphics, and lack of qualified media
Digital learning media are still used infrequently.	Utilizing effective and efficient media in the learning process	Learning platforms with insufficient training

Table 4 shows that the use of LKPD in schools when learning was still simple and relied solely on government learning resources. The teacher still dominates the learning process through the lecture and question and answer method, resulting in the teacher having a greater influence than the students. Due to students' lack of understanding of the material, one of which is lines and angles, students cannot construct mathematical ideas into images and graphics.

3.2. Formative Evaluation

3.2.1. Self-evaluation

Following a preliminary study that identified gaps between learning objectives and reality on the ground, the researchers developed an E-LKPD design that is expected to support/become an alternative solution to the problems mentioned above.



Figure 1. E-LKPD display using Canva

Figure 1 depicts an E-LKPD created with the Canva app on a smartphone. This Canva application offers a variety of interesting tools for designing various types of designs; you can even create teaching materials that are effective and efficient in their use. The E-LKPD is distributed in the form of a link that can be opened on a smartphone or laptop, making the learning process easier, and more cost-effective because it does not need to be printed, and can be equipped with audio and visuals such as embedding a video link on Google Drive or a YouTube link.

3.2.2. Designing the Prototype

Expert Review

The results of validation, individual trials, small group, field, and pilot tests were used to determine the feasibility of the E-LKPD on lines and angles using a scientific approach aided by Canva. Two material and two media expert validators validated phase I expert validation. Table 5 shows the results of stage I expert validation.

Translate:

Indicators of Competence

Achievement

3.10.4 finding the concept of Angle

3.10.5 find the measure of the angle formed by the clockwise

3.10.6 naming angle

4.10.3 solving mathematical problems related to angles

Activity 3.1

let's observe

Observe carefully Figure 1.3 below!

From the pictures above, explain the parts of each picture above that form an angle?

.....

Table 5. Expert validation at the first stage

No	Aspects Observed		Validator	Percentage		Criteria
				$\sum p$	\bar{p}	
1	Eligibility of Content		1	67%	71%	Valid
			2	75%		
2	Material Expertise	Presentation	1	71%	73%	Valid
		Eligibility	2	75%		
3	Language Eligibility		1	73%	73%	Valid
			2	73%		
4	Media Professional	Graphic	1	68%	72%	Valid
		Eligibility	2	75%		
Average Percentage of All Aspects				72%		Valid

According to [Table 5](#) of the results of the expert validation stage I that has been analyzed, the total average percentage value for all aspects with the "Valid" criteria is 72%. As a result, it can be concluded that the developed LKPD is feasible and can be used in the learning activities of junior high school class VII students. The following are expert notes that have been revised and are ready for researchers to use (see [Figure 2](#)).

<p>Komentar dan Saran</p> <hr/> <p>Sebaiknya Masalah yg Di berikan Kontesional</p> <hr/> <p>Pada Tahap menalar sebaiknya</p> <hr/> <p>di bunt Petunjuk / Langkah Kosong</p> <hr/> <p>sehingga mampu melihat pola dgn baik dan Proses Nalar lebih optimal</p>	<p>Translate:</p> <p><i>It would be better if the problem is presented contextually. At the reasoning stage, empty instructions/steps should be made so that you can see patterns well and the reasoning process becomes more optimal</i></p>
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Figure 2. LKPD revision results 2

According to the results of the Revised LKPD by experts and practitioners (see [Figure 2](#)), the LKPD is good, but the problems presented contextually are better, the approach to the material taken is appropriate, particularly using a scientific approach where the stages help students in communicating the things or problems received so that participants can present their results in front of other groups, and there will be mathematical communication between groups.

After completing stage 1, expert validation and making improvements to the product, stage 2 expert validation was completed. The results of the second phase of expert validation of student worksheet products on lines and angles using a scientific approach assisted by Canva are presented in [Table 6](#).

Table 6. Validation stage 2

No	Aspects Observed		Validator	Persentase		Criteria
				$\sum p$	\bar{p}	
1	Eligibility of Content		1	81%	82%	Very Valid
			2	83%		
2	Material Expertise	Presentation Eligibility	1	83%	85%	Very Valid
			2	88%		
3	Language Eligibility		1	90%	93%	Very Valid
			2	95%		
4	Media Professional	Graphic Eligibility	1	92%	93%	Very Valid
			2	95%		
Average Percentage of All Aspects				88%		Very Valid

According to [Table 6](#) of the results of the stage 2 expert validation that has been analyzed, the total average percentage value for all aspects is 88% with the criteria of "very valid." As a result, the developed product is extremely valid and ready for use. As a result, the developed LKPD is very feasible and can be used in class VII student learning activities.

One-on-One Evaluation

To assess a product's viability, individual tests are conducted. At this point, the respondents included three SMP Negeri 3 Ngamprah class VIII students who were chosen randomly based on their aptitude. The following are the findings from student responses to the E-LKPD (see [Table 7](#)).

Table 7. One-to-one test results

No.	Indicator	Percentage
1.	LKPD Contents Comprehension	76%
2.	Clarity of the study guidelines and data	76%
3.	LKPD exhibit suitability	79%
4.	Motivation	79%
5.	Attractiveness	70%
6.	Curiosity	84%
Average for the Category		77%
		Practical

Based on the individual test results in [Table 7](#), the average percentage of students' responses to the developed LKPD is 77% in the "Practical" category, indicating that the LKPD can be re-tested in small group tests.

Small Group Evaluation

Trials with a small group of people to evaluate the product's viability. Respondents at this stage included ten class VIII students from SMP Negeri 3 Ngamprah who were chosen

on a random basis based on ability. The following are the findings from student responses to the E-LKPD (see [Table 8](#)).

Table 8. Trial results in a small group

No.	Indicator	Percentage
1.	LKPD Contents Comprehension	76%
2.	Clarity of the study guidelines and data	73%
3.	LKPD exhibit suitability	72%
4.	Motivation	74%
5.	Attractiveness	80%
6.	Curiosity	75%
Average for the Category		75%
		Practical

According to the results of the small group trial for the E-LKPD using a scientific approach aided by Canva (see [Table 8](#)), the average percentage of scores obtained from 10 students is 75% in the "Practical" category, indicating that the developed LKPD is testable.

Field Try out

The formative evaluation concludes with field trials. The effectiveness of the E-LKPD scientific approach on students' mathematical communication abilities on lines and angles was tested in trials. As a prerequisite for determining the types of parametric and non-parametric statistics, the normality test is used. The results of the Normality Test are shown in the [Table 9](#).

Table 9. Test results for normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PRETEST	0.211	36	<0.001	0.922	36	0.015
POSTEST	0.149	36	0.043	0.933	36	0.031

a. Lilliefors Significance Correction

The results of the SPSS software-assisted normality test show that the sig. <0,05 then the decision is not normally distributed. Furthermore, proceed with the non-parametric Wilcoxon test assisted by SPSS software as an alternative to the paired sample t test. The Wilcoxon Test results, as aided by SPSS software, are presented in the [Table 10](#).

Table 10. Wilcoxon test results

	POSTEST - PRETEST
Z	-5.247 ^b
Asymp. Sig. (2-tailed)	<0.001

a. Wilcoxon Signed Ranks Test
 b. Based on negative ranks.

The Wilcoxon test results (see [Table 10](#)), as aided by the SPSS software, show that if the $\text{Sig} < 0.05$, then the decision is there is a significant influence on the mathematical communication skills of students who use E-LKPD with a scientific approach assisted by Canva. If there is a significant "Influence" on students' communication skills after the pretest and posttest and obtains "Very Effective" results.

Students are encouraged to actively study independently using this E-LKPD teaching material. E-LKPD makes it simple for students to gain access to it, allowing them to be more flexible in the learning process and efficient in their use. The Canva application offers a variety of design features to assist researchers in creating visually appealing E-LKPDs, as well as audio-visual features to entice students to study. According to another viewpoint, developing E-LKPD will enable students to participate actively, creatively, and independently in learning activities, allowing students to overcome their fear of learning mathematics (Negari et al., [2021](#); Susiana & Renda, [2021](#)).

Other studies' findings indicate that E-LKPD is useful and that students can be motivated and interested in learning activities because it makes it easier for students to understand the material and solve learning problems (Wijaya & Hidayat, [2022](#)). Students are also more enthusiastic about learning because they can work in groups, exchange opinions among friends, and are not afraid to express their opinions to the teacher when presenting the results of group work in front of the class (Lydia & Suparman, [2019](#)).

E-LKPD teaching materials take a scientific approach to guiding students in the construction of the line and angle concepts. The steps in learning are intended to guide and stimulate students to think about and discover the concepts of lines and angles. In accordance with current learning in the 2013 curriculum, which is oriented toward directing students to formulate problems and train analytical thinking so that students achieve higher learning outcomes than the traditional approach (Indarti et al., [2018](#); Nenotaek et al., [2019](#)).

After being given the E-LKPD, students' mathematical communication skills improved significantly. All aspects of the scientific approach, beginning with observing, questioning, reasoning, associating, and communicating, can be used to improve mathematical communication skills. When observing problems, students must comprehend the various contexts presented and interpret them based on their understanding. The ability to understand and interpret context is an indicator of mathematical communication ability. This is consistent with Engel ([2000](#)), which states that the ability to understand, interpret, and evaluate mathematical ideas both orally and visually is an indicator of mathematical communication ability. Furthermore, students can communicate something they know through dialogue events or reciprocal relationships that occur in the classroom environment (Rahmi et al., [2017](#)).

4. CONCLUSION

Based on the results and discussion, it demonstrates the feasibility of student worksheets on lines and angles using a scientific approach aided by Canva, according to experts and practitioners, paying attention to the results of expert and practitioner assessments can be categorized as "Very valid" and the results of practical trials are in the "Practical" category. The effectiveness of the E-LKPD on lines and angles using a scientific approach assisted by Canva on the mathematical communication abilities of Grade VII Secondary School students is that there is a significant influence on the mathematical communication abilities students using the E-LKPD with a scientific approach assisted by Canva and obtaining very effective results. As for additional research, the E-LKPD can be used to create a learning trajectory with a wider scope.

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