Development of LKPD in E-Commerce Context Using the TPS Method to Facilitate Students' Mathematical Communication Skills

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Abstract

This study aims to develop Student Worksheets (LKPD) in the context of ecommerce using the Think Pair Share (TPS) method to facilitate students' mathematical communication skills that are suitable for use in probability material. In this research, the ADDIE model with the stages of Analyze, Design, Develop, Implement, and Evaluate was used. The subjects of this study were three mathematics education lecturers and mathematics educator as validators and X RPL SMK YAPIIM Indramayu students in the 2025/2026 academic year as test subjects. The instruments used were interview guideline, LKPD validation sheet, student response questionnaire, and mathematical communication skills test sheet. The data analysis techniques involved qualitative and quantitative data. The LKPD obtained excellent validity criteria with an average of 150. The practicality of the LKPD obtained a percentage of 83.83%, which is classified as very good. The completeness of the mathematical communication skills test results obtained a score of 76.67%, which is considered effective. Thus, the developed LKPD is suitable for use because it meets the criteria of validity, practicality, and effectiveness.

Keywords: *LKPD; E-Commerce; TPS; Mathematical Communication.*

Abstrak

Penelitian ini bertujuan mengembangkan Lembar Kerja Peserta Didik (LKPD) konteks e-commerce dengan metode Think Pair Share (TPS) untuk memfasilitasi kemampuan komunikasi matematis peserta didik yang layak digunakan pada materi peluang. Penelitian ini menggunakan model ADDIE dengan tahapan Analyze, Design, Develop, Implement, dan Evaluate. Subjek penelitian ini adalah tiga dosen pendidikan matematika dan pendidik matematika sebagai validator, serta peserta didik kelas X RPL SMK YAPIIM Indramayu tahun ajaran 2025/2026 sebagai subjek uji coba. Instrumen yang digunakan berupa lembar pedoman wawancara, lembar validasi LKPD, lembar angket respons peserta didik, dan lembar soal tes kemampuan komunikasi matematis. Teknis analisis data berupa data kualitatif dan kuantitatif. LKPD memperoleh kriteria kevalidan sangat baik dengan rata-rata 150. Kepraktisan LKPD memperoleh persentase sebesar 83,83% yang termasuk kriteria sangat baik. Ketuntasan hasil tes kemampuan komunikasi matematis memperoleh nilai 76,67% sehingga dinyatakan efektif. Dengan demikian, LKPD yang dikembangkan layak digunakan karena memenuhi kriteria kelayakan valid, praktis, dan efektif.

Kata Kunci: LKPD; E-Commerce; TPS; Komunikasi Matematis.

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INTRODUCTION

National Council of Teachers of Mathematics (NCTM) has identified five key competencies in mathematics learning, namely mathematical communication, mathematical reasoning, mathematical connections, mathematical representation, and mathematical problem solving. Of these five competencies, mathematical communication plays an important role in mathematics and mathematics education. Mathematical communication helps students express ideas, construct logical arguments, and understand concepts through interaction. This competency is not only related to understanding symbols and notation, but also involves the skills of explaining, writing, and discussing concepts systematically (NCTM, 2000). In the context of learning, communication plays an important role in helping students develop a deeper understanding. The NCTM also formulates four aspects of mathematical communication, namely: (1) organizing and integrating mathematical thinking through communication; (2) communicating mathematical ideas coherently and clearly to peers, educators, and others; (3) analyzing and evaluating the mathematical thinking and strategies of others; and (4) expressing mathematical ideas accurately using mathematical language.

Students' mathematical communication skills are still relatively low. This condition is reflected in the results of preliminary studies and interviews conducted at YAPIIM Indramayu Vocational School. Based on interviews with one of the tenth-grade mathematics teachers, around 40% of students are considered to be sufficiently communicative, especially in terms of verbal communication. However, many students still experience difficulties in expressing problems in mathematical representations. This is in line with student questionnaire data showing that only 50% of students are able to explain mathematical ideas or concepts to teachers or friends in a coherent and clear manner, 60% of students have difficulty expressing mathematical ideas using symbols, tables, graphs, or diagrams, and only 43.3% are able to analyze and evaluate the mathematical thinking of others.

Handoko and Sukardi (2019) mention that communication is a soft skill required by students in Vocational High Schools (SMK). Individuals with good communication skills will find it easier to interact and adapt to new work environments (Jafri, et. al, 2024). In Hidayati, et al. (2021) research at SMK Negeri 1 Batang, communication is also a skill that is targeted in various subjects. In this case, the learning methods applied by educators also play an important role in facilitating students' mathematical communication. Ellissi and Subianti (2020) revealed that students' difficulties in mathematical communication skills are often caused by the use of conventional learning methods, such as lectures. Therefore, learning methods are needed that can encourage students to express their ideas and help students participate in the learning process.

One type of learning that can facilitate students' mathematical communication skills is cooperative learning. Cooperative learning encourages students to communicate with each other to help each other during the learning process (Khoiriyati, 2017). Cooperative learning consists of various types, such as Think Pair Share (TPS), Two Stay Two Stray (TSTS), Cooperative, Integrated, Reading, and Composition (CIRC), and so on. This method has different stages. Aulia and Rajagukguk (2017) showed that in a study comparing learning with the TPS and TSTS methods on mathematical communication skills, the TPS method was more effective in facilitating students' mathematical communication skills. In addition, research by Khairunisa and Basuki (2021) also shows that the TPS method is more effective than the CIRC method. These findings are one of the considerations in choosing the TPS method to facilitate students' mathematical communication skills.

TPS can develop structured thinking skills in discussions and provide opportunities for students to work independently or collaborate with others through more effective communication (Khoiriyati, 2017). The results of a preliminary study conducted at SMK YAPIIM Indramayu support the TPS method in facilitating students' mathematical communication skills. Based on questionnaire data, 90% of students have participated in learning using the TPS method, 50% of students feel more confident in expressing mathematical ideas

when learning through discussion, and 80% of students better understand their friends' explanations when discussing mathematical problems. The results of interviews with tenth-grade mathematics teachers also support this. Teachers stated that the TPS method has been used several times in mathematics learning, although it has never been applied to probability material. According to the educators, this method can encourage students to discuss and express their opinions. To further optimize the TPS method, Nurdin et al. (2017) stated that learning with the TPS method would be more meaningful if it were linked to real situations experienced by students, so that the material would not only be understood conceptually but also internalized in everyday life.

In everyday life, there are various contexts that can be used as learning materials, for example, the context of e-commerce. E-commerce or electronic commerce is the buying and selling of goods and services conducted via the internet. Riswandi et al. (2019) state that e-commerce is part of the digital economy that enables companies, consumers, and certain communities to connect through electronic transactions. Various platforms such as Shopee, Lazada, Bukalapak, Blibli, and Tokopedia have become the main choices for people in conducting online transactions (Fitriyani et al., 2021). The existence of e-commerce also makes it easier for business actors to manage and develop their businesses (Kasmi & Candra, 2017). Not only the general public, but the convenience offered by ecommerce has also attracted the interest of students who are increasingly accustomed to this service in their daily lives (Mustajibah, 2021). The widespread use of e-commerce among students shows that e-commerce has become part of their daily lives (Tandirerung & Patta, 2022).

This is reinforced by the results of a survey conducted at SMK YAPIIM Indramayu, which shows that 96.6% of students are aware of e-commerce and have engaged in online shopping. In fact, 86.7% of students expressed interest in learning mathematics material related to online shopping. These findings show that e-commerce is a familiar and interesting context for students. From the interview results, the 10th grade mathematics teacher at SMK YAPIIM Indramayu confirmed that learning is often linked to everyday life. Although the

context of e-commerce has never been used, educators state that the use of e-commerce contexts has the potential to attract students' interest. E-commerce provides various examples that are relevant to mathematics learning. In online shopping activities, for example, consumers are often faced with choices of various products with different brands, prices, and quantities in stock. In addition, data such as purchase history, product reviews, and recommendation systems also reflect the tendency or frequency of an event occurring. These various situations have great potential to be used to study probability, especially 10th grade probability material.

Probability is a branch of mathematics that discusses the likelihood of an event occurring under uncertain conditions (As'ari, et al., 2017:286). According to Husna (2021:43), probability can also be interpreted as a measure of the level of certainty regarding the occurrence or non-occurrence of an event. In the Merdeka Curriculum, this material is considered important because it links mathematical concepts to real-life situations that are familiar to students. Therefore, students need to understand probability material in depth and contextually. Herdiansyah (2017) revealed that many students find it difficult to solve probability problems due to their lack of concrete understanding. They often only imagine abstract situations, such as throwing dice, without relating them to real-life situations. This was also conveyed by a 10th-grade mathematics teacher at SMK YAPIIM Indramayu, who mentioned that probability learning is still dominated by the use of tools such as balls, money, or dice. In fact, research by Albab and Damayanti (2022) shows that calculating probabilities in a certain way can attract students' interest, thereby stimulating discussion and active communication in the classroom. In line with this research, the results of a preliminary study questionnaire also indicate that 93.3% of students are more interested in learning about probability if it is related to everyday life. In fact, 96.7% of students expressed interest in learning about probability in the context of e-commerce. To integrate this, teaching materials that support learning are needed, one of which is the Student Worksheet (LKPD).

LKPD is a tool used in learning to enrich the learning experience of students and make the learning process more interesting and creative (Hajid, 2024). As a medium of communication in the classroom, LKPD enables the learning process to take place in a structured and interactive manner, both between educators and students and among students themselves (Astuti & Sari, 2017). The results of an interview with a mathematics teacher of grade X at SMK YAPIIM Indramayu stated that students are already familiar with the use of LKPD and respond to it enthusiastically. The teacher assessed that LKPD would be very helpful if it was clearly structured, because its use could save time and make it easier for students to directly do the exercises. This is reinforced by survey data showing that 80% of students like using LKPD in mathematics learning and find it easier to understand the material when using LKPD compared to other media. In addition, 86.6% of students stated that they were more interested in working on LKPD containing daily activities, and 86.7% of students were interested in learning using LKPD in the context of e-commerce to study probability material. The use of LKPD encourages students to actively learn, both independently and in groups, thereby increasing their involvement in the learning process (Meisya et al., 2018). Therefore, LKPD is a teaching material that needs to be optimally designed to suit the characteristics of the learning activities carried out and to be able to support the achievement of the targeted basic competencies (Khoiriyati, 2017).

Several studies have shown the effectiveness of using LKPD in learning. Latifah (2023) successfully developed a valid, practical, and effective LKPD for 10th grade probability material. Another study by Khoiriyati (2017) developed a valid and practical LKPD based on the TPS cooperative learning model, but it was not fully effective in improving mathematical communication skills. Meanwhile, Wiwitan's (2024) research developed context-based worksheets for e-commerce in statistics material, which were found to be highly valid, practical, and effective.

Based on these findings, the development of LKPD that integrates the context of e-commerce and the TPS method shows great potential in supporting mathematics learning, particularly in facilitating students' mathematical

communication skills in grade 10 probability material. However, no research has been found that specifically develops LKPD with the TPS method in probability material in the context of e-commerce. Therefore, the researcher intends to develop learning media in the form of e-commerce context LKPD with the TPS method to facilitate students' mathematical communication skills.

RESEARCH METHODS

This research is a type of research and development using the ADDIE development model. ADDIE consists of five stages, namely analyze, design, develop, implement, and evaluate. The subjects in this study were two mathematics education lecturers and one mathematics educator as validators, as well as grade X RPL students at SMK YAPIIM Indramayu as test subjects. The selection of students was carried out using purposive sampling. The types of data used in this study consisted of quantitative and qualitative data. The data collection instruments used in this study were interview guidelines, preliminary study questionnaires, LKPD assessment sheets, student response questionnaires, and student mathematical communication skills test sheets. The data analysis techniques used were product validity analysis, product practicality analysis, and product effectiveness analysis.

RESULTS AND DISCUSSION

The analyze stage involves analyzing conditions and situations, analyzing student characteristics, and analyzing the curriculum and materials. This analysis was conducted through interviews with mathematics teachers of grade X at SMK YAPIIM Indramayu. Analysis of the conditions and situation showed that mathematics learning in the 10th grade at SMK YAPIIM Indramayu had been running smoothly, but learning resources were still limited to textbooks, which were considered incomplete. Teachers sometimes created student worksheets and PowerPoint presentations, but had never developed specific worksheets for probability material. Teachers also used the TPS method several times and saw a positive impact on students' mathematical communication skills. Furthermore,

analysis of student characteristics through questionnaires shows that most students have a high interest in learning that is relevant to everyday life, especially activities related to digital technology such as online shopping. Forty percent of students are communicative verbally, but still have difficulty expressing mathematical ideas or strategies systematically and explaining their mathematical ideas to both their peers and teachers. In addition, it is known that students also prefer group learning. Analysis of the curriculum and materials shows that the independent curriculum is implemented at YAPIIM Indramayu Vocational School. The probability material taught includes the addition rule, multiplication rule, sample space, probability of an event, expected frequency, and compound events. However, this study only focuses on the addition rule, multiplication rule, sample space, and probability of an event, which are delivered in four meetings. Probability learning has so far still used abstract contexts such as balls and dice. Based on the results of this analysis, the development of e-commerce context worksheets using the TPS method to facilitate students' mathematical communication skills, especially in probability material for grade X, can be an alternative solution.

The design stage is carried out as a continuation of the analysis stage that has been carried out previously. Product development is tailored to the learning conditions and situation, the characteristics of the students, and the applicable materials and curriculum. The design carried out at this stage consists of three parts, namely compiling the LKPD design, compiling the LKPD structure, and creating the research instrument design. In developing the design, the title, references, and learning objectives are also determined. The LKPD is then developed with an introductory section containing the front cover, LKPD identity, foreword, table of contents, instructions for use, TPS method, mathematical communication skills, interrelationships between variables, concept map, learning outcomes, learning objectives, introduction to figures, and introduction to e-commerce. The content section includes activity 1 and activity 2 to be completed by students. Each activity consists of let's think, let's pair up, let's discuss, and let's

practice activities. The closing section contains a summary, bibliography, author profile, and back cover.

In addition, research instruments were also designed during the design stage by creating an LKPD assessment sheet, a student response questionnaire, a student mathematical communication skills test sheet, and a teaching module. The LKPD assessment sheet is used to determine the validity of the LKPD, focusing on aspects of content suitability, language suitability, presentation suitability, graphics, suitability with TPS, and suitability with e-commerce. The student response questionnaire sheet will be used to determine the practicality of the developed LKPD. The assessment focuses on the aspects of attention, interest, confidence, and satisfaction, which are described in 20 statements. On the test sheet, it is presented as a posttest in the form of an essay test. Each question represents one of the indicators of mathematical communication skills. The mathematical communication indicators used in this study refer to NCTM with the following adjustments: (1) organizing and explaining mathematical ideas in a coherent and clear manner; (2) expressing mathematical ideas using appropriate symbols, tables, graphs, or mathematical diagrams; and (3) analyzing and evaluating the mathematical thinking and strategies of others. The entire research instrument sheet is designed in the form of a grid. Finally, the teaching module is designed as a guideline for educators using the developed LKPD. This teaching module includes the identity and general information of the module, learning activity steps, assessment, and reflection.

The development stage is the process of realizing the design that was created in the previous stage and evaluating the product. This is in line with Ilyas's (2015: 55) opinion, which states that one of the important points in this stage is to conduct an assessment by experts before the product is implemented in learning. The activities carried out in this stage are developing the LKPD design, developing research instruments, assessing the validity of the LKPD, and making revisions based on suggestions and input from experts. After the LKPD and research instruments have been developed according to the design that has been prepared, the LKPD will be assessed for validity by a validator. The quantitative

data obtained from the assessment will be processed by determining the overall average score using the formula according to Sujana (2014: 109) as follows:

$$\bar{X}=\frac{\Sigma x}{n}$$

Explanation:

$\bar{X}$ = Average score

Σx = Total score

n = Total assessors

The validity of the product was assessed using a Likert scale. The scoring rules for this Likert scale were based on the scoring guidelines provided by Widoyoko (2012: 105). The "Very Good" category receives a score of 4, the "Good" category receives a score of 3, the "Less Good" category receives a score of 2, and the "Not Good" category receives a score of 1. After obtaining the average score from all aspects assessed, the next step is to analyze these scores to determine the product validity criteria. The assessment criteria are determined based on established references, namely using the expert assessment criteria guidelines according to Widoyoko (2022: 238) as listed in Table 1 below.

Table 1. LKPD Assesment Criteria

Interval	Criteria
$X > \bar{X}_i + 1{,}8 \times SBi$	Very Good
$\bar{X}_i + 0{,}6 \times SBi < X \leq \bar{X}_i + 1{,}8 \times SBi$	Good
$\bar{X}_i - 0{,}6 \times SBi < X \leq \bar{X}_i - 1{,}8 \times SBi$	Fair
$\bar{X}_i - 1{,}8 \times SBi < X \leq \bar{X}_i - 0{,}6 \times SBi$	Poor
$X \leq \bar{X}_i - 1{,}8 \times SBi$	Very Poor

Explanation:

X = Empirical average score

$\bar{X}_i$ = Ideal average score obtained using the formula:

$\bar{X}_i$ = $(\frac{1}{2})$ × (ideal maximum score + ideal minimum score)

SBi = $(\frac{1}{6})$ × (ideal maximum score − ideal minimum score)

Ideal maximum score = 4

Ideal minimum score = 1

The developed LKPD product is declared valid if the LKPD assessment results from experts meet the minimum criteria of "Good" (Widoyoko, 2022: 242).

The assessment results show that the LKPD developed is valid with an average score of 150 and is classified as excellent. In terms of the average score for each aspect, the content feasibility aspect scored 35, the language feasibility aspect scored 20, the presentation feasibility aspect scored 15, the graphic feasibility aspect scored 28, the suitability of the LKPD with the TPS method scored 19, and the suitability with e-commerce scored 33. Table 2 presents a summary of the LKPD assessment results conducted by 3 experts.

Table 2. Results of LKPD Validity Assessment

Number of questions	42
Ideal maximum score	269
Ideal minimum score	42
X	150
$\bar{X}_{\text{i}}$	105
SBi	21
Assesment	Very Good

Based on the LKPD validity criteria listed in Table 1, the developed LKPD is in the X > 142,8 interval, which is categorized as very good. Thus, the LKPD shows that the e-commerce context LKPD with the TPS method to facilitate students' mathematical communication skills is valid. The fourth stage, implementation, was carried out through field trials. The field trials were conducted over four meetings. The first meeting completed activity 1, the second meeting completed activity 2, the third meeting worked on and discussed practice questions, and the fourth meeting administered a mathematical communication skills test and a student response questionnaire. The LKPD was implemented in class X RPL. Class X RPL was selected using purposive sampling with the criterion of an even number of students. This stage was carried out to determine the practicality of the LKPD as seen from the results of the student response questionnaire and the effectiveness of the LKPD as seen from the results of the students' mathematical communication skills test.

The final stage is the evaluation stage. According to Wiwitan (2024), evaluation is carried out at each stage as an improvement and consideration for the next stage. At this stage, the effectiveness and practicality of the LKPD are evaluated. Practicality data is obtained from the results of a questionnaire responding to students' use of the LKPD after conducting a trial with the LKPD. The assessment of the student response questionnaire uses a Likert scale. The scoring rules on this Likert scale use the scoring guidelines according to Widoyoko (2012: 105). The "Very Agree" category received a score of 4, the "Agree" category received a score of 3, the "Disagree" category received a score of 2, and the "Very Disagree" category received a score of 1. After the data was collected, the average score for each aspect was calculated using the formula:

$$average\ score = \frac{total\ score}{total\ assessors}$$

Then, the average score is converted into a percentage using the following formula:

$$Percentage\ of\ Ideality\ (\bar{p}) = \frac{average\ score}{ideal\ maximum\ score} \times 100\%$$

The percentage score is then analyzed to be categorized into several criteria. The assessment criteria are adjusted to the provisions in the expert assessment criteria table according to Widoyoko (2022: 242) as listed in Table 3 below.

Table 3. Ideal Assessment Percentage Criteria

Interval	Criteria
$\bar{p} > 80\%$	Very Good
$60\% < \bar{p} \leq 80\%$	Good
$40\% < \bar{p} \leq 60\%$	Fair
$20\% < \bar{p} \leq 40\%$	Poor
$\bar{p} \leq 20\%$	Very Poor

The LKPD product developed is considered practical if the results of the student response questionnaire show a minimum criterion of "Good" (Widoyoko, 2022: 242). The results of the student response questionnaire on the LKPD assessment obtained an average score of 67,07 with an ideal percentage of 83,83%. Based on the LKPD practicality criteria in Table 3, the developed LKPD

is in the $\bar{p} > 80\%$ interval with a very good criterion. Thus, the results of the LKPD practicality assessment show that the e-commerce context LKPD with the TPS method to facilitate students' mathematical communication skills is declared practical. The analysis of product effectiveness was conducted by referring to the results of mathematical communication ability tests taken by students after participating in learning using LKPD. The assessment of the mathematical communication ability test instrument used a Likert scale. The scoring rules on this Likert scale used the scoring guidelines according to Widoyoko (2012: 105). The "Very Good" category received a score of 4, the "Good" category received a score of 3, the "Less Good" category received a score of 2, and the "Not Good" category received a score of 1. The data obtained from the mathematical communication skills test was processed by calculating the average test score. From this average, the percentage of students who obtained a score higher than or equal to the Learning Objective Achievement Criteria (KKTP) at the school, which is 75, will be determined using the following formula:

$$p = \frac{p_a}{p_b} \times 100\%$$

Explanation:

p = Percentage of student completion

p_a = Number of students who have completed

p_b = Total students

After obtaining the student completion rate, it will then be analyzed and categorized into several categories. The assessment categories are adjusted to the academic assessment table according to Widoyoko (2022: 242) as listed in Table 4 below.

Table 4. Academic Proficiency Assessment Criteria

Interval	Criteria
$\bar{p} > 80\%$	Very Good
$60\% < \bar{p} \leq 80\%$	Good
$40\% < \bar{p} \leq 60\%$	Fair
$20\% < \bar{p} \leq 40\%$	Poor
$\bar{p} \leq 20\%$	Very Poor

The LKPD product developed is considered effective if the academic proficiency assessment results meet the minimum criterion of "Good" (Widoyoko, 2022: 242).

The results of the students' mathematical communication skills test show that 23 out of a total of 30 students obtained a score greater than or equal to the Learning Objective Achievement Criteria (KKTP) at school, which is 75. Then, the percentage of student mastery is calculated using the following formula:

$$p = \frac{p_a}{p_b} \times 100\%$$

Based on these calculations, a mastery percentage of 76,67% was obtained. After analysis, this percentage was adjusted to the academic proficiency assessment criteria in Table 4. Thus, it was found that the mastery percentage was in the interval 60% < $\bar{p} \leq$ 80% with a good criterion. Therefore, the results of the LKPD practicality assessment show that the e-commerce context LKPD with the TPS method to facilitate students' mathematical communication skills is effective.

CONCLUSION

This study produced LKPD in the context of e-commerce using the TPS method to facilitate students' mathematical communication skills. The validity of the LKPD was rated "Very Good" with an overall average score of 150, thus declared valid. The practicality of the LKPD showed a "Very Good" rating with an ideal percentage of 83,83%, thus the developed LKPD was declared practical. The effectiveness of the LKPD showed a completion rate of 76,67% and obtained a "Good" criterion, so it was declared effective. Thus, the e-commerce context LKPD with the TPS method to facilitate students' mathematical communication skills that was developed is suitable for use because it meets the criteria for a product, namely valid, practical, and effective.

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