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THE DEVELOPMENT OF LIVEWORKSHEETS-ASSISTED PROBLEM-BASED LEARNING TEACHING MATERIALS TO IMPROVE STUDENTS' MATHEMATICAL COMMUNICATION SKILLS

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ABSTRACT

This study aims to measure the level of validity, practicality and effectiveness of Problem Based Learning social arithmetic teaching materials assisted by Liveworksheets. This study uses the Research and Development (R&D) method of Sugiyono's development model which consists of 10 stages which are limited to step 7, namely: potential and problems, data collection, product design, design validation, design revision, product trial, and product revision. The research subjects were: a VII grade math teacher, 10 VIII grade students, and 30 VII grade students. Instruments in this study include: interview sheets, validation sheets, student response questionnaires, and mathematical communication skills tests. Data processing techniques in the form of quantitative data analysis include validity analysis, practicality analysis, and effectiveness analysis of test results. The results of this study that LKPD teaching materials have met the eligibility criteria. This is because based on the results of the validation of experts who get a score of 80% which is considered valid. In the limited product trial, a score of 81% was obtained in the very practical category. As well as extensive product trials obtained a score of 85% with a very practical category. Then during the effectiveness test, it got a score of 80% with the effective category. Thus teaching materials in the form of learner worksheet are suitable for use in the learning process.

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INTRODUCTION

Communication skills are one of the must-have skills for 21st century learning. Mathematical communication skills are important for students to master (Chasanah, Riyadi & Usodo, 2020). Students' mathematical communication skills really need to be improved, because through

mathematical communication students can carry out their mathematical thinking organization (N. I. P. Putri & Sundayana, 2021). In line with what was revealed by Hendriana, Rohaeti & Sumarno (2017), that mathematical communication is an essential ability and needs to be possessed by students. The reasons underlying the question of the importance of students' mathematical communication skills include: a) curriculum and math learning objectives; b) In principle, mathematics is a symbol language that is structured, efficient and capable of quantitative analysis; c) mathematical communication ability is an outcome that must be achieved in teaching and learning.; d) mathematical communication ability is one of the abilities that must be learned because it has a strong strength in the formulation of mathematical concepts and strategies; e) mathematical communication skills are basic in solving, constructing, solving mathematical problems and are a forum for discussion related to the results of the solutions that have been obtained; f) mathematical communication is widely used in other fields of study.

The reality in the field shows that mathematical communication skills are still low. Based on observations at Al-Inayah Junior High School, information was obtained that most students were in the low category for their mathematical communication skills because teachers rarely gave test questions according to the indicators of mathematical communication skills, the teaching materials used only contained material and practice questions without any design and form of varied questions. In addition, the lack of using the right learning model in accordance with the material and the needs of students so that students are less active in the learning process. Ariawan and Nufus (Hendriana & Kadarisma, 2019) argues that the cause of students' low mathematical communication skills is because students are less able to communicate mathematical ideas in mathematics learning. According to Surya, Juniati & Syahputra (2018), low communication skills are caused by several factors, one of which is that the learning process is still teacher-centered, where the teacher still does not have the right model or strategy in delivering the material being taught. In line with the research results Nababan (2018), that the low mathematical communication skills of students occur because of the attitude of students who tend to pay less attention to teachers in the mathematics learning process, in addition to the low interest in learning mathematics caused by tedious and uninteresting learning, the use of media / props is not optimal, the lack of interaction between teachers and students and interaction between students and students. Based on the results of this study, it can be seen how important mathematical communication skills are for students, especially in learning mathematics.

Social arithmetic is material related to everyday life. Some previous studies concluded that children still have difficulties in solving social arithmetic problems. Kurniati, Said & Hidayat (2019), stated that students' difficulties in working on social arithmetic problems include students having difficulty in understanding concepts, skills, principles and facts. According to Lestari, Rohaeti & Senjayawati (2019), students' difficulties in solving arithmetic problems are 2, namely concept difficulties and verbal difficulties, as well as students still have difficulty in making mathematical models, have trouble knowing what to look for, and summarize the learning outcomes. The cause of these difficulties is due to low mathematical communication skills, teachers' difficulties in providing models and approaches that are appropriate to the material and conditions of the students being taught, besides the lack of teaching materials provided to students as a tool in the learning process.

Judging from these problems, there must be a development of teaching materials that are more interactive and attract student interest and can be opened and read anywhere. In learning activities, the role of teaching materials is important by choosing the appropriate learning model. With teaching materials, learning becomes interesting, students get the opportunity to learn independently, and also get the opportunity to learn and find it easy and learn the

competencies that must be mastered (Sholeh & Sutanta, 2019). Teachers are required to have the creativity to compile and develop teaching materials that are innovative, varied, interesting and in accordance with the curriculum, student needs and technological developments (Magdalena et. al., 2020). One of the teacher's innovations is to make the LKPD more interesting. LKPD is one of the teaching materials that is very important to support the quality of learning both individually and in groups (Hariyati & Rachmadyanti, 2022).

The learner worksheet can be implemented with current technological developments. One form of technology in the LKPD development process is using the Liveworksheets website. This website allows students to access the learner worksheet anywhere. Therefore, the learner worksheet in this study was developed into an electronic learner worksheet. According to Panjaitan, Mansyur & Saputra (2023), to make the electronic learner worksheet more interesting and easily understood by students, it should not only contain words but also be balanced with illustrations to motivate students so that they are not bored and interested in working on it. Based on the research conducted by Putri, Siswanto & Mawaddah (2023), The results of the validity calculation and practical test of media or electronic learner worksheet teaching materials assisted by Liveworksheets proved to be valid and feasible to use and can help instill and develop students' mathematical communication skills. Nurwijayanti & Sulisworo, (2022), stated based on the analysis, from the measurement of usefulness with a percentage of 80%, aspects of user convenience with a percentage of 83%, aspects of ease of learning with a percentage of 65%, and aspects of satisfaction with a percentage of 84%. The overall usage measurement produces a feasibility percentage value of 78% which shows that the results of the user measurement of Electronic learner worksheet assisted by Liveworksheets have criteria worthy of use and can improve students' mathematical communication skills. In line with the research Magfiroh, Ayuningtyas & Savitri (2023), based on data analysis using descriptive qualitative analysis and quantitative percentage shows that cycle I obtained an average indicator of 18.3%, cycle II with an average indicator of 37.3%, and cycle III with an average indicator of 63%. This shows that the use of Liveworksheet in learning can improve students' communication skills.

Optimizing learning activities in the classroom can be done by selecting a learning model that is appropriate or has an influence on the abilities to be developed (Hanipah & Sumartini, 2021). The learning model that has continuity with mathematical communication skills is the Problem Based Learning (PBL) model. According to Hafely et. al. (2018), Problem Based Learning is a learning strategy by exposing students to practical problems as a foothold in learning, and based on his research that the Problem Based Learning model has a significant effect on students' mathematical communication skills. This is indicated by the average value of the pre-test of students' mathematical communication skills is lower than the average value of the post-test of students' mathematical communication skills. This is what was revealed by Yanti (2017), PBL intends to provide free thinking space for students to find concepts and solve problems related to the material taught by the teacher at school. Based on the results of his research, the communication skills using the Problem Based Learning model are better than conventional learning. This is evidenced by the results of the analysis which shows that students taught using the Problem Based Learning model obtained a better average score and increased by 15% higher than students who studied conventionally. In line with Jaya, Waluyo & Siswanto (2019), PBL is one of the models oriented towards contextual learning where students gain knowledge from solving real problems that are closely related to students' daily lives through independent or group learning. PBL begins by exposing students to problems, the teacher's role is to facilitate student inquiry in an effort to solve problems. Based on the results of his research, the mathematical communication skills of SMA 4 Semarang students

increased through the implementation of the Problem Based Learning model on SPLTV material. This can be seen from the average evaluation results of students' mathematical communication skills in cycle I in the high category and cycle II in the very high category, with classical completeness of 75% and 88.57% respectively. Based on this description, it can be concluded that the application of the Problem Based Learning model and the use of Liveworksheets media can be a solution in improving students' mathematical communication skills.

Thus, the authors were inspired to make efforts to optimize more active learning by developing teaching material products in the form of Learner worksheet so that it can facilitate teachers and students in the learning process. So based on the description above, this study aims to measure the level of validity, practicality and effectiveness of teaching materials for social arithmetic based on Problem Based Learning assisted by Liveworkshets on mathematical communication skills of junior high school students.

METHOD

This research uses the Research and Development (R&D) development model of Sugiyono (2009). According to Mahfud & Fahrizqi (2020), development research is a research based on making an effective product, starting with needs analysis, product development, and product trials. Meanwhile, according to Mahfud & Yuliandra (2020), development research is a research that aims to develop a new product or improve existing products. In Sugiyono's development model, There are 10 stages of research, namely: 1) potential and problems; 2) data collection; 3) product design; 4) design validation; 5) design revision; 6) product trial; 7) product revision; 8) usage trial; 9) product revision; 10) mass production. However, the limitations on the time aspect of conducting research up to step 7 are sufficient to test the validity, feasibility and effectiveness of a developed product.

So the steps that must be followed by researchers to produce products include stages: 1) potential and problems; research starts from the potential and problems that occur in this field can be by direct observation in the field or based on existing research reports. 2) data collection; researchers collect data from various sources that will be used as material for designing products that are applied in overcoming problems that occur in the field. 3) product design; at this stage the product design of teaching materials is compiled. 4) design validation; product validation is an activity to assess whether the product design that has been made is feasible to use or not (Destiana, Suchyadi & Anjaswuri, 2020), At this validation stage, researchers presented two material experts and one practitioner. 5) design revision; Design revision is carried out after obtaining an assessment from experts. All input, criticisms, suggestions and recommendations from experts and experienced teachers are recorded and used as a basis for improving the design of teaching materials developed.

The next stage, 6) product trials; product trials aim to see the attractiveness, feasibility and effectiveness of the teaching materials developed. this product trial stage consists of limited trials and broad trials. The limited trial was conducted on 10 students of Al-Inayah Junior High School class VIII. The broad trial was conducted on 30 students of Al-Inayah Junior High School grade VII. 7) product revision; after the limited trial and broad trial are carried out, if there are no revisions and the product has been declared valid and practical so that no further trials are carried out. Furthermore, this teaching material can be implemented as one of the learning resources in the teaching and learning process. Based on the stages that have been described, the flow of this research can be seen in the following figure:

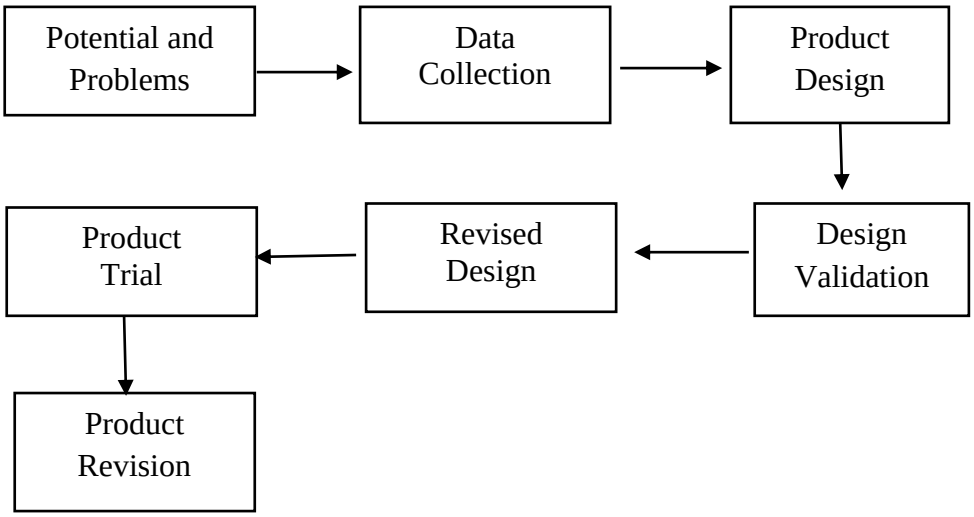

Figure 1. Sugiyono's Development Model Chart (2009)

The research location was held at Al-Inayah Junior High School Parakantugu Kec. Cijati Kab. Cianjur in the 2022-2023 school year. The research subjects were: a VII grade mathematics teacher, a limited trial of 10 VIII grade students of Al-Inayah Junior High School who had studied social arithmetic material, and a broad trial of 30 VII-A grade students of Al-Inayah Junior High School who had not studied social arithmetic material.

The instruments in this study include: interview sheets, validation sheets, student response questionnaires, and mathematical communication skills tests. Interviews were conducted during the preliminary study, namely to a teacher who teaches math classes to obtain data related to problems in the field or as an identification of potential problems. The validation sheet was given to material experts consisting of two lecturers and one practicing teacher with the aim of obtaining an assessment that whether or not the Learner worksheet teaching materials developed were feasible to be tested. Student response questionnaires were given as a practitioner test to obtain data on the practicality of the materials developed. Meanwhile, the test was used to determine the effectiveness of teaching materials on mathematical communication skills. The test instrument was prepared based on indicators of mathematical communication skills.

The data collection technique in this study is a test question in the form of a description aimed at seeing students in solving mathematical communication problems on social arithmetic material. The answers were analyzed based on indicators of mathematical communication skills, including: writen text, drawing, and mathematical expressions. Techniques to see the validity of Problem Based Learning teaching material products assisted by Liveworksheets using validity analysis, data processing techniques to determine the practicality of teaching materials obtained through student response questionnaires using practicality analysis, and processing student final tests using effectiveness analysis.

Product validation analysis was carried out through the assessment of validation sheets that had been filled in by 2 IKIP Siliwangi lecturers and AL-Inayah Junior High School mathematics teachers. Product validation was reviewed from the components of content feasibility, presentation feasibility, language feasibility, suitability to the learning model and suitability to mathematical communication skills. This validation uses four levels of assessment, namely: "very good = 4", "good = 3", "less = 2" and "very less = 1". Furthermore, it is calculated using the following formula (Fitriani, Hidayah & Nurfauziah, 2021).

$$expert\ validation = \frac{total\ empirical\ score}{total\ expectation\ score} \times 100\%$$

After obtaining the expert validation value, then from the validity criteria in the following table (Fitriani, Hidayah & Nurfauziah, 2021).

Table 1. Validity Criteria

Validity Criteria	Validity Level
80% < V ≤ 100%	Very valid
60% < V ≤ 80%	Valid
40% < V ≤ 60%	Valid enough
20% < V ≤ 40%	Less valid
0% < V ≤ 20%	Invalid

Analysis of the practicality of teaching materials was obtained from questionnaires filled out by students during limited trials and extensive trials. This student response questionnaire has 16 questions which are divided into positive statements and negative statements. Covering aspects of appearance, presentation and benefits. The following are 4 levels of weighted scores for assessing product practicality: a) score for positive statements, namely; "strongly agree = 4", "agree = 3", disagree = 2", "strongly disagree = 1". b) score for negative statements: "strongly agree = 1", "agree = 2", disagree = 3", "strongly disagree = 4". Then calculated using the following formula (Fitriani, Hidayah & Nurfauziah, 2021).

$$Final\ Grade = \frac{Total\ Score}{Maximum\ Score} \times 100\%$$

After obtaining the final practicality score, then see the criteria in the following table (Krismadinata, Anwar & Akbar, 2021).

Table 2. Practicality Criteria

Practicality Criteria	Practical Level
80% < P ≤ 100%	Very Practical
60% < P ≤ 80%	Practical
40% < P ≤ 60%	Practical enough
20% < P ≤ 40%	Less Practical
P ≤ 20%	Impractical

The effectiveness technique is carried out to see the effectiveness of the use of teaching materials developed, with the following stages: a) giving a score to each instrument item, b) calculating the total score of all instrument items, c) giving an effectiveness value with the following formula (Sugandi, Sofyan & Maesaroh, 2021).

$$Final\ Grade = \frac{Total\ Score}{Maximum\ Score} \times 100\%$$

After obtaining the value of the effectiveness test, the criteria are made in the following table (Sugandi, Sofyan & Maesaroh, 2021)

Table 3. Effectiveness Test Criteria

Practical Criteria	Practical Level
81 % - 100%	Very Effective
61 % - 80%	Effective
41 % - 60%	Effective Enough
21 % - 40%	Ineffective
0% - 20%	Very ineffective

RESULTS AND DISCUSSION

Results

The development of teaching materials which are learner worksheet assisted by Liveworksheets begins with a preliminary study, at this stage the researcher conducts a literature study and field survey by conducting observations and interviews with mathematics teachers at Al-Inayah Parakantugu Junior High School to find out the problems that occur in the classroom, especially in mathematics subjects, and to obtain answers about the situation and conditions of students and schools. Then the researchers collected various sources of information in the form of materials and theories to support product development, then the researchers developed learner worksheet using problem-based learning assisted by Liveworksheets. Liveworksheets is an educational website created in late 2016 by Victor Gayol that gives teachers the freedom to turn printed worksheets into online and more interactive exercises. The website can also auto-check allowing students to work on worksheets and submit them online to the web (Nurbayani et al., 2021). Liveworksheets is a free web service including the creation of interactive learner worksheet that can be accessed through Google with the link www.liveworksheets.com but in its use must register using email to get an account (Loe et al., 2022). The following researchers present one of the designs of learner worksheet teaching materials assisted by Liveworksheets.

Figure 2. Design of Learner Worksheet

The next stage of teaching materials is validated by material experts where material validation is carried out by two material experts and one practitioner expert, namely two lecturers and one teacher. The results of validation from two experts and one practitioner on teaching material products can be seen in the following table:

Table 4. Recapitulation of material expert assessment based on the aspects assessed

Aspects Observed	Percentage	Category
Content / Material Feasibility	84%	Very valid
Presentation Feasibility	79%	Valid
Language Suitability	76%	Valid
Suitability of Problem-Based Learning Model	81%	Very valid
Alignment with Mathematical Communication Skills	79%	Valid
Average	80%	Valid

The next stage is the revision of teaching materials in accordance with the criticisms and suggestions given by validators and practitioners. The results of the validation provided information to researchers regarding deficiencies in the products developed, namely the lack of details of the material discussed, formulas should not be presented directly, there are errors in the placement of images, motivational words should be added and there should be additional instructions from the transition of the problem into the problem. One example of improvement is as below:

Figure 3. Improvement of Electronic Learner Worksheet Design Assisted by Liveworksheets

The next stage of limited product testing was carried out by 10 students who had studied social arithmetic with low, medium, and high student categories. Students were given a response questionnaire containing 16 questions which were divided into positive statements and negative statements. The purpose of the student assessment in the limited test is to find out the student's response to the developed learner worksheet.

Table 5 . Limited Trial Results

Number of students	Average percentage	Criteria
10	81%	Very Practical

Based on the results of student responses from filling 16 with 10 students, a percentage of 81% was obtained by referring to the criteria for practicality, the percentage value was included in the interval 80% < P ≤ 100%, so it was categorized as very practical.

The next stage is a broad trial, similar to the limited trial, students are asked to respond to the learner worksheet developed. In the broad trial, it was given to 30 seventh grade students as respondents who evaluated the learner worksheet products developed. The results of student responses are presented in the following table.

Table 6. Broad Trial Results

Number of students	Average percentage	Criteria
30	85%	Very Practical

Based on the results of student responses from filling out 16 statements which are divided into positive statements and negative statements with 30 students, the percentage is 85% by referring to the practicality criteria, the percentage value is included in the interval 80% < P ≤ 100%, so it is categorized as very practical.

The effectiveness of the learner worksheet products developed can be seen from the results of the post-test assessment conducted when conducting a broad product test. The results of student post-tests can show the effectiveness of learner worksheet products because post-tests are given after learning using learner worksheet products. The questions contained in this effectiveness trial were adjusted to the students' mathematical communication skills. The results of the effectiveness test that has been carried out can be seen in the table below:

Table 7. Effectiveness Test Results

Indicator	**Question No.**	**Percentage**	**Category**
Writen text	1	83%	Highly Effective
Drawing	2	77%	Effective
	3	79%	Effective
Mathematical expressions	4	80%	Effective
Average		80%	Effective

From the average results of each indicator, a percentage of 80% is obtained by referring to the effectiveness category, the value is in the interval 61% - 80% with effective criteria. Based on the results of the effectiveness test, it states that the use of learner worksheet teaching materials using Problem Based Learning assisted by Liveworksheets on the mathematical communication skills of VII grade junior high school students can be said to be effective.

Discussions

This research began in the preliminary study found obstacles experienced by teachers in the learning process, especially in mathematics lessons, namely teaching materials that are less innovative so that one of the abilities that students must have in learning mathematics, namely mathematical communication skills is still low. It is hoped that the development of learner worksheet teaching material products developed by researchers can help the learning process become more effective and interesting. This is in line with the results of the research Magdalena et. al. (2020), namely the existence of teaching materials can improve the learning process to be effective and interactive. The next stage is data collection where researchers look for sources of information, theories and several references that support based on the applicable curriculum, then make teaching material assessment instruments in the form of validation sheets that will be assessed by validators, practicality sheets in the form of student response questionnaires and tests that are aligned with indicators of mathematical communication skills.

Next is to make a product design, at this stage the researcher designs an learner worksheet product using the Problem Based Learning (PBL) model assisted by Liveworksheets. The presentation of material on LKPD must be in accordance with the steps of the Problem Based Learning (PBL) model, such as: orienting students to the problem, organizing students in learning, assisting individual and group investigations, developing and presenting work and analyzing and evaluating the problem solving process. In addition, the presentation of questions in the learner worksheet must be in accordance with the components of Liveworksheets such as essay questions, moving questions, matching questions and multiple choice questions. The next stage is to carry out the validation stage I, based on the research results described above, it is known that the learner worksheet product has met the "valid" criteria. In this validation, researchers also received comments and suggestions on the products developed, so that researchers made revisions to the product in accordance with the suggestions given by the validator. This is by making modifications or improvements according to expert advice to get a conclusion that can be tested at school (Setiawan, 2021).

At the limited product trial stage, researchers asked students to assess the learner worksheet developed. Students were very interested in the learner worksheet product because they had never received teaching materials using Liveworksheets. With the questioning stage, students will feel more understanding because they ask things that are not yet known. In accordance with research Prijanto & Kock (2021), that is question and answer in learning can increase interaction between students and teachers and between students and students. In the broad product trial process, students conducted learning using the developed learner worksheet with 6 meetings, 5 meetings for learning and 1 meeting to conduct an effectiveness test by giving post-test questions based on mathematical communication skills. In addition, students also filled out questionnaires to assess the products developed. The results of students' answers to the practicality test of the limited product trial and the broad product trial obtained the eligibility criteria "very practical". Based on the interpretation of the scores and percentages obtained, it shows that the teaching material products in the form of learner worksheet developed meet the eligibility criteria for use. This is in line with the opinion of research Effendi et al. (2021), The developed learner worksheet product is suitable for use if it gets results with the interpretation "valid/worthy/very feasible/very practical". Liveworksheets-

assisted mathematics teaching materials have been tested for validity and practicality. In accordance with what Borg and Gall said (Fortuna, Yuhana & Novaliyosi, 2021) that educational development research is a process used to develop and validate educational products. The result of development research is not only the development of an existing product but also to find knowledge or answers to practicality.

The effectiveness of the developed learner worksheet teaching materials can be seen from the results of the post-test conducted after students get learning with the Problem Based Learning model learner worksheet developed using Liveworksheets. The tests given to students were aligned with the indicators of mathematical communication ability. This test is used to measure the effectiveness of learner worksheet products developed on mathematical communication skills. Based on the results of the effectiveness test table, it is known that in general students are able to write explanations and mathematical reasoning with correct and easy-to-understand language on the writen text indicator. In the drawing indicator, students are able to express their mathematical ideas into tables and diagrams. The last indicator is mathematical expressions, where students are able to express mathematical concepts into mathematical language or mathematical models. Analysis of students' mathematical communication skills is seen from the average results in the effectiveness test of each indicator, which is in the "effective" category. This shows that there is a relationship between the learning process using the learner worksheet products developed with students' mathematical communication skills. In line with research Syasri, Hasanuddin & Noviarni (2018) , The average percentage of the post-test is in the "effective" category, this shows that the learner worksheet product can facilitate mathematical communication skills. Thus learner worksheet teaching materials using Problem Based Learning assisted by Liveworksheets can be used as teaching materials in the learning process.

CONCLUSION

Teaching materials for learner worksheets using Problem Based Learning assisted by Liveworksheets are feasible, practical and effective. Based on the results of the validity test, the teaching materials developed are in the valid or feasible category and can be used with little improvement. Based on the practicality test from the results of the student response questionnaire, the teaching materials developed are in the very practical category for use. The results of the effectiveness test of teaching materials developed are in the effective category, which means that the teaching materials developed have a relationship or influence on mathematical communication skills. Suggestions from further researchers, this development can be carried out until the next stage, because the development that researchers do is only 7 of 10 development procedures. To become a permanent teaching material, it is necessary to improve teaching materials from the aspects of content, material, presentation and language feasibility because the teaching materials developed have not met the ideal value of material experts and practitioners. In addition, it is necessary to develop teaching materials assisted by Liveworksheets with other materials and different abilities.

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