Development of E-Worksheet To Improve Students' Mathematical Problem Solving Ability

Pengembangan E-LKPD untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Peserta Didik

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ABSTRAK
Tujuan dari penelitian ini untuk menghasilkan media pembelajaran berupa lembar kerja peserta didik yang praktis dan efektif. Selain itu, penelitian ini juga untuk meningkatkan kemampuan pemecahan masalah matematis peserta didik tingkat sekolah menengah atas kelas X pada materi sistem persamaan linear tiga variabel. Metode yang digunakan adalah metode R&D (*Research and Development*) dengan model 4D (*Define, Design, Development dan Disseminate*). Uji validitas dilakukan oleh guru matematika, dosen matematika dan dosen ahli media. Hasil penelitian menunjukkan media yang telah dikembangkan berdasarkan hasil uji validitas dalam aspek kualitas tampilan 94,79% dengan kategori sangat baik, text tulisan 93,75% dengan kategori sangat baik, dan rekayasa perangkat 94,79% dengan kategori sangat baik. Media yang dikembangkan diuji praktis oleh 10 responden. Uji praktikalitas didapatkan hasil kualitas tampilan 99,16% dengan kategori sangat baik, hasil text tulisan 99,37% dengan kategori sangat baik, dan hasil rekayasa perangkat 100% dengan kategori sangat baik. Hasil nilai kemampuan pemecahan masalah matematis peserta didik memperoleh nilai rentang 75-100 dari hasil menjawab e-worksheet, sehingga rata-rata yang didapat dari setiap peserta didik pada kemampuan pemecahan masalah matematis dalam kategori "tinggi" dan rata-rata persentase diperoleh 94,10% dalam kategori "sangat baik". Berdasarkan hasil perolehan data menunjukkan bahwa media e-worksheet pada materi sistem persamaan linear tiga variabel layak digunakan sebagai sumber belajar dan juga dapat meningkatkan kemampuan pemecahan masalah matematis peserta didik.
Kata kunci: Pengembangan E-Worksheet, Kemampuan Pemecahan Masalah

ABSTRACT
The purpose of this research is to produce learning media in the form of practical and effective student worksheets. In addition, this research is also to improve the mathematical problem solving ability of high school students in class X on the material of a three-variable system of linear equations. The method used is the R&D (Research and Development) method with a 4D model (Define, Design, Development and Disseminate). The validity test was carried out by mathematics teachers, mathematics lecturers, and media expert lecturers. The results showed that the media that had been developed based on the results of the validity test in the aspect of display quality was 94.79% in the very good category, the written text was 93.75% in the very good category, and device engineering 94.79% in the very good category. The developed media was tested practically by 10 respondents. The practicality test showed that the display quality was 99.16% in the very good category, the text results were 99.37% in the very good category, and the results of the device engineering were 100% in the very good category. The results of the students' mathematical problem solving ability scores ranged from 75 to 100 from the results of answering e-worksheets, so that the average obtained from each student on mathematical problem-solving abilities was in the "high" category and the average percentage obtained was 94.10% in the "very good"

category. Based on the results of data acquisition, it shows that the e-worksheet media on the material of a three-variable linear equation system is feasible to be used as a learning resource and can also improve students' mathematical problem-solving abilities.
Keywords*: E-Worksheet Development, Problem Solving Ability*

PRELIMINARY

Learning in the digital era facilitates educators in teaching to make it look attractive and easy to understand. Learning with interesting teaching materials can help students master the material better. Thus, educators can facilitate teaching materials in technology-based learning. According to Setiawan (Rohaeti & Lusiyana, 2020), education treats technology well, because education is the main learning media to understand and master a lesson. Learning is currently done without having to face to face. So that students can learn regardless of time and place. Students must also be competent, creative and independent in problem solving. This kind of learning uses a strategy in one form of learning. Agree with Pamungkas, Subali, & Linuwih (2017) which states that a learning process that is capable of or able to support the creativity of students' learning is needed.

Blended learning is a learning that uses classes with online networks or learning media, either face-to-face or online discussions using chat forums (Rohaeti & Lusiyana 2020). Blended learning is implemented as a varied learning design, where students play an active role in developing problem-solving skills. The blended learning model is also a learning aid to make it more effective and efficient and to increase interaction, which is guided by learning media with its advantages (Haka, Anggita, Anggoro, & Hamid, 2020). The learning process in schools through online is still a lot of students who have difficulty, especially in learning mathematics. This agrees with Fitriani, Hidayah, & Nurfauziah (2021a) who state that students have difficulty understanding mathematical concepts and are less motivated, besides that mathematics is seen as abstract with non-interactive teaching materials. The creativity that educators must do is to use teaching materials that are as attractive as possible so that they can be used for online and offline learning. One of the interactive and interesting teaching materials that can be used by educators is the student worksheet. Agree with Wahyuni, Candiasa, and Wibawa (2021) that worksheet is

one of the teaching materials that plays an important role in giving assignments that are relevant to the material being taught.

Worksheet is a teaching material to make it easier for students to understand learning. By using this L worksheet, educators expect students to be more active, not only listening and watching, but can write or do exercises (Handayani, Pujiastuti, & Suhito, 2014). According to Apertha, Zulkardi, & Yusup (2018), worksheet is a learning tool that is used as a complement or support for the learning implementation lesson plan. This agrees with Janah (2020) that success in learning mathematics is how teachers design plans in the learning process, how teachers bring methods and models or strategies in the learning and teaching process in order to achieve maximum goals.

The innovation that will be applied in this research uses worksheet, one of which is by integrating worksheet into e-worksheet This study chose to use media in the form of e-worksheet not using other media because during the Covid-19 pandemic, educators gave questions in an ineffective way in the form of print or paper so that educators really needed effective media in the form of e-worksheet. This is supported by the opinion of Hilda and Siswanto (2021) stating that with the rapid technological advances, educators must use up to date learning media. Agree with Siswanto, Hilda, & Azhar (2019) stating the development of learning media using online tools can increase the effectiveness and efficiency of student learning. E-worksheet in this study is also defined as a learning media designed online in which it discusses material and work in a structured manner to make it look attractive and achieve the expected goals. In addition, e-worksheet can be used in the learning process to be more interesting. Students are actively involved and interested in learning than learning to use worksheet in the form of print or paper media (Khikmiyah, 2021). Agree with Puspita & Dewi (2021) stating that the use of e-worksheet provided by educators in the learning process has a good impact on students making it more fun, motivating students to learn and making learning interactive. In addition, the use of the e-worksheet can save internet usage or quotas in accessing learning to use the e-worksheet with the liveworksheets application. Liveworksheets is a medium that converts traditional or printed worksheets into interactive online ones (Fitriani, Hidayah, & Nurfauziah, 2021b).

The use of e-worksheet is inseparable from the goal of educators to develop mathematical abilities. In the process of learning mathematics, it is expected that educators can cultivate the five mathematical abilities. One of the mathematical skills that must be mastered by students is the ability to solve mathematical problems. The ability to solve

mathematical problems is very important for students to learn mathematics as a means for students to understand, solve, plan, and find solutions to obtain non-routine strategies (Isnaini, Duskri, & Munzir 2016; Nur & Palobo 2018; Pradani & Nafi'an 2019; Shodikin 2016). In solving problems, some students often feel satisfied or proud of the results of their own work even though it is not necessarily true, but it is not uncommon for students to feel unable to solve complex problems and some students are also not confident about the results they are doing. This makes many students feel pessimistic about whether they can solve new math problems when given (Nuraeni &s Rosyid 2019).

This study chose the three-variable linear equation system material because in this material, students were asked to understand a problem that was involved in the question. There are many students who avoid solving problems that require high ability in solving mathematical problems (Fitra & Anshari, 2016). In fact, most students still rely on memorization in mathematics to face and solve mathematical problems (Farida, 2015). This makes problem-solving skills very important as a basic ability that every student must master and possess and is in line with Ince's (2018) opinion that problem-solving skills play an important role and become the main basis for the 21st century generation. Widiyanti & Nisa (2021) states that e-worksheet can help students practice problem-solving skills both academically and in everyday life.

Several studies on worksheet have been carried out. First, Septina, Farida, and Komarudin (2018) conducted research on the development of worksheet with a scientific approach based on problem-solving abilities at the junior high school level which encourages students to actively participate in mathematics lessons so that further research can be developed even better, considering that there are still many shortcomings in making and its development. Second, Andriyani et al. (2020) conducted research on the application of PBL learning assisted by e-worksheet in increasing student activity, with the result that at the elementary level, this application could increase student activity. Third, Pratiwi & Yuliana (2021) conducted research on the development of the 7E learning cycle-oriented e-worksheet at the high school level that further implementation was needed to see the effectiveness of using the developed e-worksheet. So with this, there is no research that examines the development of e-worksheet to improve students' mathematical problem-solving abilities at the high school level.

In the initial observation that was carried out on January 14 to January 20, 2022 in 2 schools at the high school level in Jakarta, it was found that students' mathematical problem-solving abilities were still in the low category. This can be seen from the answers

of students in the initial observations. In addition, the teaching materials used by students in both schools are still in the form of manual worksheets, which are less effective for use during online and offline learning. This is the same as research conducted by Rahmawati (2021) she found that online learning reduces interaction between educators and students, material becomes difficult to understand, media is less supportive, less student motivation and an online learning environment that is too monotonous. Thus, the purpose of this research is to produce a learning product in the form of e-worksheet and improve students' mathematical problem-solving abilities in blended learning.

Unlike previous research, this review aims to produce learning media in the form of e-worksheet and improve students' abilities in innovative and creative learning. It positions students as learning subjects according to the learning presented. With this, research and development of learning media using e-worksheet is carried out to improve students' mathematical problem-solving skills in three-variable linear equation system material to obtain practical and effective media.

METHOD

The development model used in this research is the 4D (Define, Design, Development dan Disseminate) development model. This model includes research and development research. The 4D development model is one of the models for developing learning media devices to help students learn. The 4D development model consists of four main stages, namely define, design, develop, and disseminate. The define stage determines and analyzes the needs in the process and collects various information related to the product to be developed. The next stage is the design stage to design a media or teaching material that can be used to help facilitate learning mathematics. The develop stage aims to produce a revised one based on experts and product trials. In the design process from the previous stage, the results are revised based on experts and trials. Validation from experts serves to validate mathematics, media, and language materials. The completed e-worksheet is assessed by material expert teachers, material expert lecturers, and media expert lecturers. The product trial is carried out after validation by an expert, then the e-worksheet is tested in a limited field to determine the feasibility of the e-worksheet. After the validation tests, product trials, and instruments have been revised, the next stage is the disseminate stage, the purpose of this stage is to disseminate the e-worksheet.

The sampling technique used in the trial was purposive sampling. Purposive sampling technique is a technique used to determine and collect samples determined by a

researcher with certain considerations. The considerations that will be carried out in this research are students who have studied the material presented in the e-worksheet so that the quality of the e-worksheet made can be used and in accordance with the wishes of students and the learning objectives to be achieved. The research location is one of the senior high schools in Jakarta for the 2021-2022 academic year, grade X MIPA 1 for development and testing.

The validation of the media and learning materials produced was carried out by validator of media experts and material experts and then analyzed using a descriptive percentage technique with the formula according to Sudijono (Pramadana, Soro, & Siswanto, 2019), namely:

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

Information :

f : Frequency being searched for percentage

N : Number of cases (Number of frequency/number of individuals)

P : Percentage figures

Google form data processing uses a Likert scale, following the scoring used.

Table 1. Likert Scale Explanation

Alternative Answer	Score for Statement
Very Good (VG)	4
Good (G)	3
Not Good (NG)	2
Very Not Good (VNG)	1

The results of the assessment in the form (%) are then given a percentage range and the following criteria:

Table 2. Percentage Range and Media Eligibility Criteria

Percentage Range	Criteria
86% - 100%	Very Good
75% - 85%	Good
60% - 75%	Enough
≤55%-59%	Not Good

Indicators of problem solving ability in this study include understanding the problem, planning a solution, implementing the plan and interpreting the results obtained. These four indicators must fulfill every problem that exists because these four indicators are a systematically interrelated stage that is used to find solutions to problem solving and

obtain the correct final result. Data processing for the achievement of mathematical problem-solving abilities, along with the scoring used.

Table 3. Achievement of Mathematical Problem Solving Ability

Score	Category
83,00 - 100	Very Good
70,00 - 82,00	Good
55,00 - 69,99	Enough
40,00 - 54,99	Not Good
0 - 39,99	Very Not Good

RESULT AND DISCUSSION

This research resulted in a media or teaching material in the form of e-worksheet, a digital learning media in mathematics subjects for three-variable linear equation system material for high school students. Like Puspita & Dewi (2021) developing e-worksheet as an effectiveness in the investigative approach to critical thinking skills. In addition, Fitriyah and Ghofur (2022) created an e-worksheet with a PBL learning model to improve students' critical thinking. And Subakti, Marzal, & Effendi (2021) developed an e-worksheet using a STEM-based discovery learning model to improve mathematical creative thinking. From some of these relevant studies, it certainly supports researchers to develop a technology-based learning media which is expected to be the target of supporting students' mathematics learning activities.

Media Planning or Teaching Materials

The teaching material being tested by the public is liveworksheets. There are 4 e-worksheet with worksheet material. E-worksheet 1 three-variable linear equation system material using the elimination method, e-worksheet 2 three-variable linear equation system material using the substitution method, e-worksheet 3 three-variable linear equation system material using the combined method (elimination and substitution), and e-worksheet 4 three-variable linear equation system material using the determinant method.

Figure 1. Initial Display of E-Worksheet 1,2,3, and 4

Figure 1 is an image of the initial display of e-worksheets 1,2,3, and 4. E-worksheet 1 using the elimination method, e-worksheet 2 using the substitution method, e-worksheet 3 using the combined method (elimination and substitution), and e-worksheet 4 using the determinant method.

Figure 2. Second page of core competencies, basic competencies and indicators of achievement of E-Worksheet competencies 1,2,3, and 4

Figure 2 is an image after the initial display of the e-worksheet. There are core competencies, basic competencies and indicators of competency achievement. Where each e-worksheet has core competencies, basic competencies and indicators of competency achievement which are on the second page after the initial display.
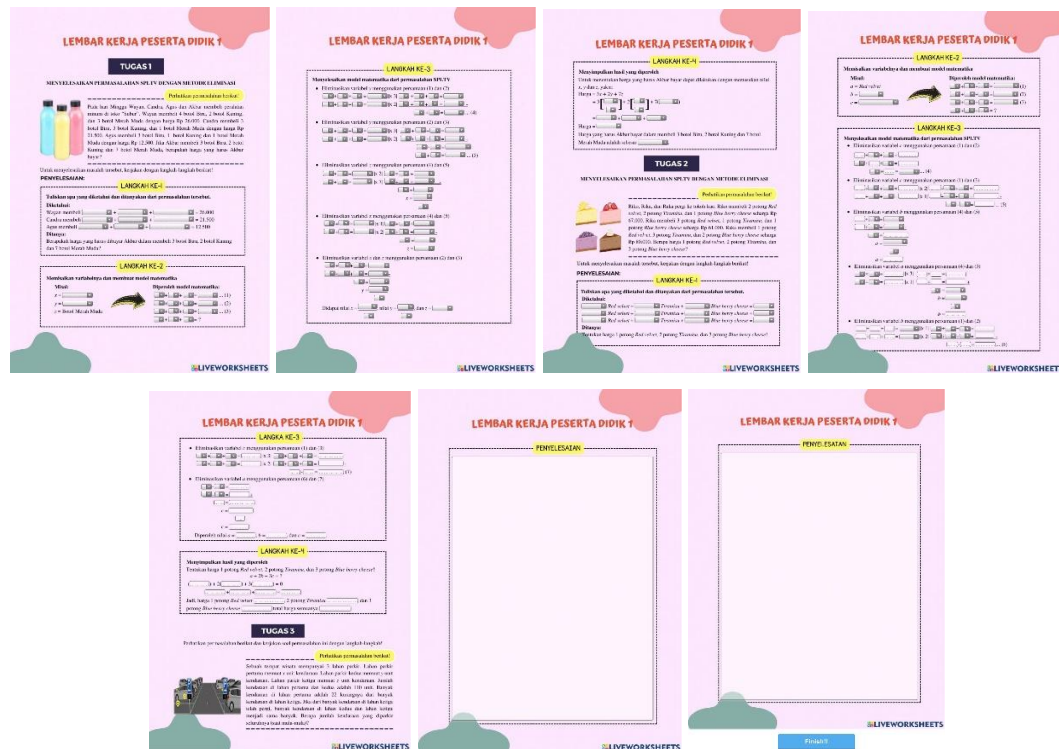

Figure 3. Display of E-Worksheet 1 Tasks

Figure 3 is a picture after the core competencies, basic competencies, and indicators of competency achievement. This page contains practice questions where task 1 is directed

in detail and to answer it in the form of multiple choice, task 2 is directed in detail to answer it in the form of multiple choice and essay, task 3 is not directed to answer it in the form of an essay as a whole. This is a display of practice questions for tasks 1 to 3 on e-worksheet 1 using the elimination method.
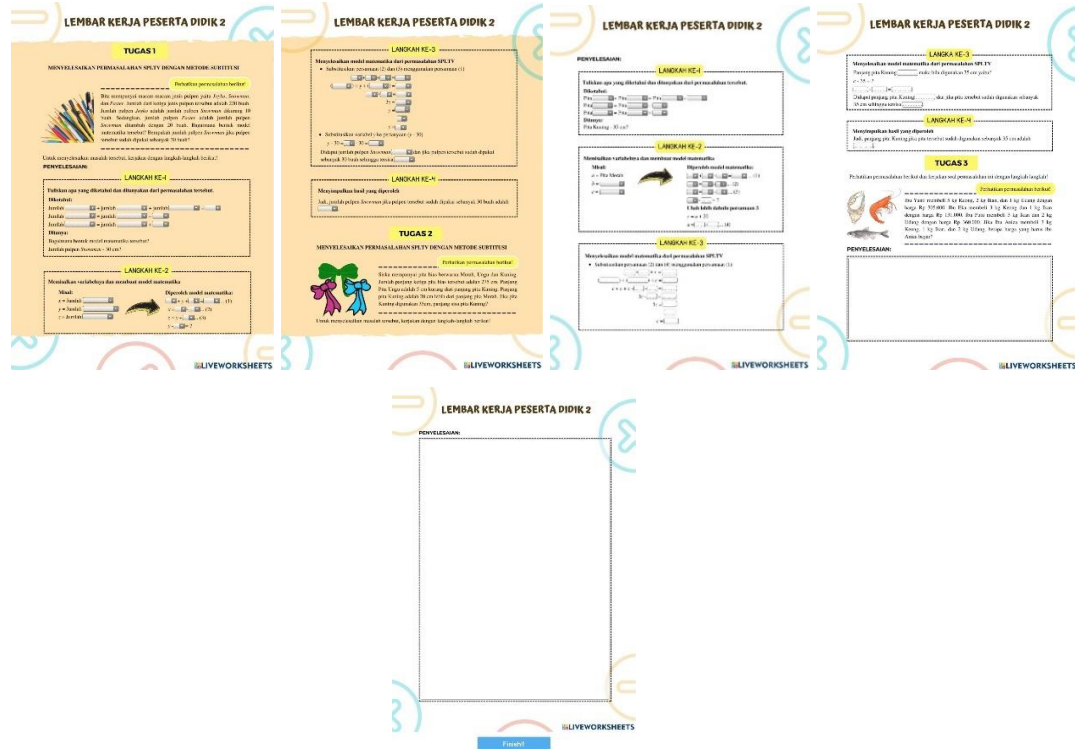

Figure 4. Display of E-Worksheet 2 Tasks

Figure 4 is a picture after the core competencies, basic competencies, and indicators of competency achievement. This page contains practice questions where task 1 is directed in detail and to answer it in the form of multiple choice, task 2 is directed in detail to answer it in the form of multiple choice and essay, task 3 is not directed to answer it in the form of an essay as a whole. This is a display of practice questions for tasks 1 to 3 on e-worksheet 2 using the substitution method.
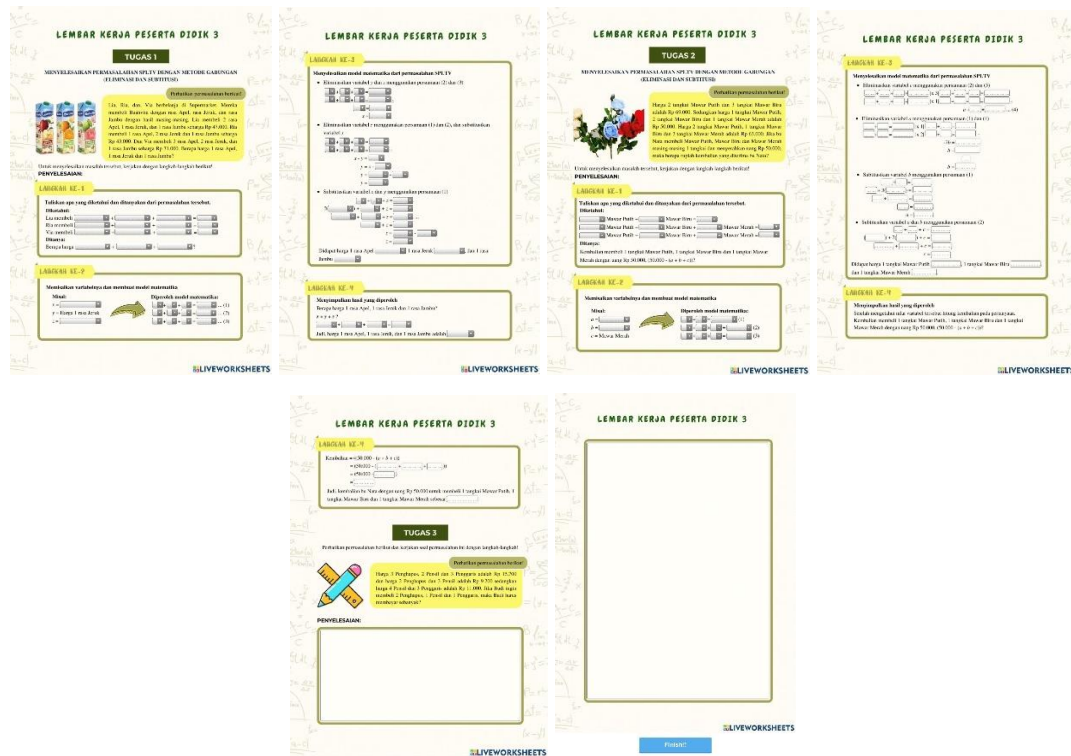
Figure 5. Display of E-Worksheet 3 Tasks

Figure 5 is a picture after the core competencies, basic competencies, and indicators of competency achievement. This page contains practice questions where task 1 is directed in detail and to answer it in the form of multiple choice, task 2 is directed in detail to answer it in the form of multiple choice and essay, task 3 is not directed to answer it in the form of an essay as a whole. This is a display of practice questions for tasks 1 to 3 on e-worksheet 3 using the combined method (elimination and substitution).
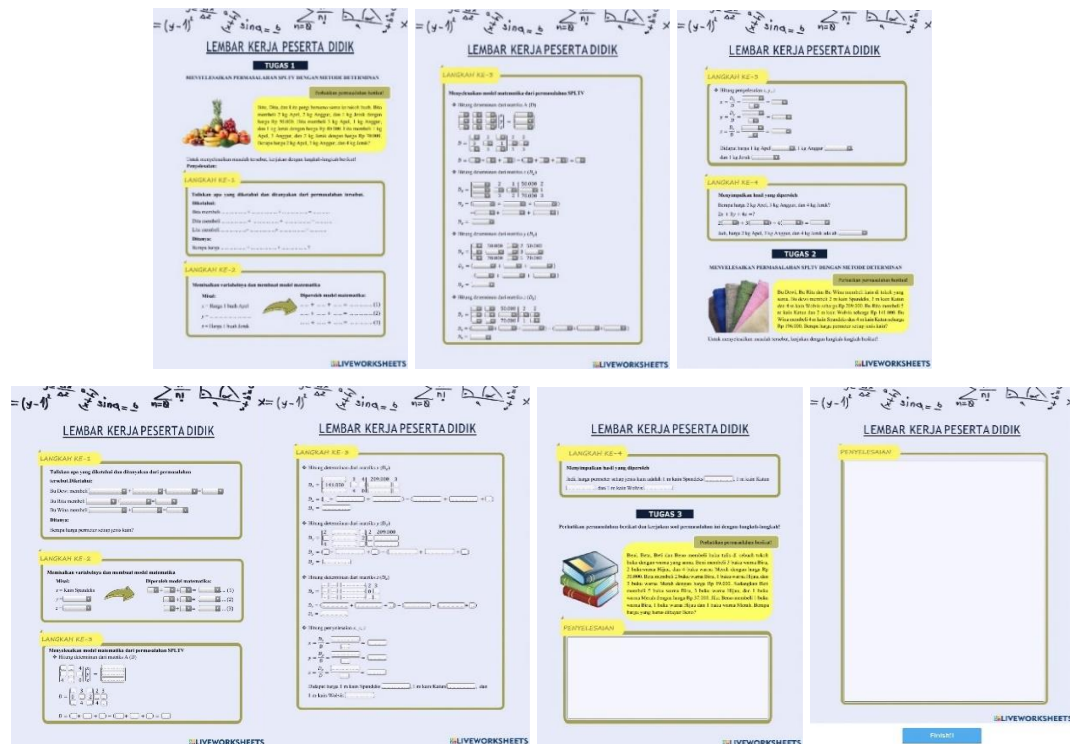
Figure 6. Display of E-Worksheet 4 Tasks

Figure 6 is a picture after the core competencies, basic competencies, and indicators of competency achievement. This page contains practice questions where task 1 is directed in detail and to answer it in the form of multiple choice, task 2 is directed in detail to answer it in the form of multiple choice and essay, task 3 is not directed to answer it in the form of an essay as a whole. This is a display of practice questions for tasks 1 to 3 on e-worksheet 4 using the determinant method.

The results of the revision of the media or teaching materials, one of which is in the form of display quality and written text, so that students have an attractive power, not only curious about how it looks but also curious about practice questions in the e-worksheet to do.

This e-worksheet media or teaching materials can be accessed anywhere and anytime. The e-worksheet soft file can be downloaded on the liveworksheets following the e-worksheet link https://bit.ly/Link_E-LKPD_1, https://bit.ly/Link_E-LKPD_2, https://bit.ly/Link_E-LKPD_3, https://bit.ly/Link_E-LKPD_4.

Data analysis

Stages of data analysis after the media or teaching materials have been made. The stages of data analysis here are carried out to measure the extent to which the media or teaching materials are feasible and can be used. There are 2 tests carried out in this stage, namely the validity test and practical test (target users).

1. Validity test

The validity test was carried out to experts, where in this study there were 4 experts used in the validity test. This validity test uses a questionnaire via google form which contains 16 statements and 3 aspects of assessment that have a score of 1 to 4. The results of the validity test are as follows.

Table 4. Validity test

Name	Display Quality						Writing Text				Device Engineering					
	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6
AMH	3	4	4	4	3	4	4	3	4	3	3	4	4	4	3	4
SS	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4
N	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4
W	4	4	3	3	3	4	3	4	4	4	4	4	4	4	3	3
Percentage	94,79 %						93,75%				94,79%					
Average Percentage							94,44%									

Table 4 is a table of the results of the validity test given to 4 reviewers, consisting of 2 mathematics teachers, 1 mathematics lecturer, and 1 media expert lecturer. From the table, the results of each reviewer's review of the e-worksheet are obtained.

Table 5. Validity Test Results

Assessment Aspect	Number of Items	Maximum Score	Earning Score	Percentage	Category
Display Quality	6	96	91	94,79%	Very Good
Writing Text	4	64	60	93,75%	Very Good
Device Engineering	6	96	91	94,79%	Very Good

Table 5 shows the calculation of 3 aspects of the assessment, where the percentage of display quality is 94.79% in the very good category, the written text is 93.75% in the very good category, and device engineering is 94.79% in the very good category. This shows very good assessment criteria with a range of 86% to 100%. So it can be said that the media or e-worksheet teaching materials with the calculated validity test are valid. These results also show that the developed media or e-worksheet teaching materials are suitable for use.

These results indicate that the e-worksheet is ideal in accordance with the criteria or size that you want to measure properly in terms of learning materials and media. In terms of the subject matter contained in the e-worksheet, there is 1 material with 4 different models. The results of the calculation show that all experts state that all materials are

relevant to the theme, content and material of the e-worksheet. This means that the material in the e-worksheet is suitable for use in the e-worksheet, considering that the validity has declared it valid.

2. Practicality Test

The practical test was carried out with 10 high school students from class X MIPA 1, while the questionnaire used through the google form contained 16 statements and 3 aspects of the assessment, which had a score of 1 to 4.

Table 6. Practical Test

Name	Display Quality						Writing Text				Device Engineering					
	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6
SR	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4
AK	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
AF	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4
AN	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4
AS	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
H	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
SY	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
AR	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
AIK	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
CKD	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Percentage	99,16%						99,37%				100%					
Average Percentage	99,51%															

Table 6 is a table of practical test results with 10 students as respondents, the percentage of each aspect of the assessment is obtained, the display quality is 99.16%, the writing test is 99.37% and the device engineering is 100%. So that the average resulting from the percentage is 99.51%.

Table 7. Practical Test Results

Assessment Aspect	Number of Items	Maximum Score	Earning Score	Percentage	Category
Display Quality	6	240	238	99,16%	Very Good
Writing Text	4	160	159	99,37%	Very Good
Device Engineering	6	240	240	100%	Very Good

Table 7 shows the calculation of 3 aspects of the assessment, where the percentage of display quality is 99.16% in the very good category, the written text is 99.37% in the very good category, and device engineering is 100% in the very good category. This shows very good assessment criteria with a range of 86% - 100%. So it can be said that the media

or e-worksheet teaching materials with practical tests that have been calculated are of very good value. These results also show that the developed media or e-worksheet teaching materials are suitable for use by students.

Table 8. Results of Mathematical Problem Solving Ability Score

Name	Value of E-Worksheet				Average	Category
	1	**2**	**3**	**4**		
SR	89	75	90	80	83.50	Very Good
AK	94	93	92	91	92.50	Very Good
AF	95	98	92	99	96.00	Very Good
AN	96	97	97	89	94.75	Very Good
AS	96	92	95	94	94.25	Very Good
H	100	100	100	80	95.00	Very Good
SY	100	100	100	100	100.00	Very Good
AR	99	100	99	96	98.50	Very Good
AIK	94	100	84	88	91.50	Very Good
CKD	99	100	85	96	95.00	Very Good

From the data exposure in table 8 there are results of the students' problem-solving ability scores. From this data, students scored a range of 75 to 100 from the results of answering the e-worksheet, then it can be seen that only 1 student got a score of 75 and other students were above the range of 80 to 100. So that the average obtained from each student on mathematical problem-solving ability is in the "high" category and the average percentage obtained is 94.10% in the "very good" category where the range of the very good category is 83 to 100. Thus, e-worksheet can be used in mathematics learning to improve students' solving abilities.

The results of the development of e-worksheet to improve problem-solving skills developed in this study are very valid, both from the material and as a learning medium, and the e-worksheet developed is very practical and effective. Research by Wahyuni et al. (2021) concluded that the development of e-worksheet based on higher order thinking skills developed was categorized as very valid, practical and effective, both from the material and as a learning medium. Thus, it can be concluded that the learning media in the form of e-worksheet can improve students' mathematical abilities.

The results of the practicality test show that the developed e-worksheet is categorized as very practical. Specifically, aspects of convenience, usability and attractiveness are also categorized as very practical. These results show that educators do not experience difficulties or obstacles in implementing it. The application of e-worksheet

also does not require a long time and a lot of energy. Educators only ask students to access the site provided to run e-worksheet. Educators only monitor student learning outcomes, which they do by answering the questions. In addition, e-worksheet is equipped with a scoring system with an assessment rubric.

In terms of usability, e-worksheet certainly helps students carry out innovative learning processes. Especially in the midst of a pandemic like today. Using electronic-based worksheets certainly makes it easier for educators to teach and also students in learning. By using e-worksheet it is certainly in accordance with the demands of the times and the material taught in e-worksheet has been adjusted to current problems. This certainly makes e-worksheet more useful for students and educators. In terms of attractiveness, e-worksheet is designed according to the needs of students and the characteristics of students. The pictures presented are able to provoke the curiosity of students because they are close to the daily lives of students. This is intended, so that learning is not too heavy for students, which actually causes students to be lazy to use e-worksheet.

CONCLUSION

Based on the results and discussion, it was concluded from the calculation of the validity test and practical test of the media or e-worksheet teaching materials that were proven valid, besides that the e-worksheet teaching materials could improve students' mathematical problem-solving abilities. This means that e-worksheet teaching materials can be accepted by students if they are applied in mathematics learning as a innovation of practical, effective and efficient mathematics learning media.

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