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DEVELOPMENT OF INTERACTIVE E-LKPD BASED ON PBL TO IMPROVE MATHEMATICAL PROBLEM SOLVING SKILLS IN TRIGONOMETRY MATERIAL TENTH GRADE HIGH SCHOOL STUDENTS

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Abstrak
Tujuan penelitian tertulis untuk mengidentifikasi fitur-fitur E-LKPD interaktif berbasis problem based learning dengan memiliki sifat-sifat valid, praktis, serta efektif dalam meningkatkan sebuah kemampuan pemecahan masalah matematika siswa SMA kelas X pada materi trigonometri. Model pengembangan ADDIE diterapkan dalam pengembangan E-LKPD interaktif melalui pemanfaatan website Liveworksheet. Uji praktikalitas dilaksanakan dengan menggunakan UEQ (User Experience Questionnaire), uji validitas serta kesesuaian pada media dilaksanakan dengan menggunakan angket asesmen LORI, dan uji efektivitas dilaksanakan dengan menilai kelengkapan tes kemampuan pemecahan masalah. Uji validitas materi serta kelayakan media menggunakan angket penilaian LORI, uji kepraktisan materi menggunakan UEQ, serta uji keefektifan menggunakan ketuntasan tes kemampuan pemecahan suatu masalah. Uji kelayakan materi dengan persyaratan yang sangat ketat. Uji kelayakan media memiliki standar yang sangat tinggi. Kriteria sangat baik pada uji kepraktisan diberikan pada guru dengan siswa kelas X SMA Negeri 1 Tabanan meliputi angket disetiap area. Keefektifan E-LKPD interaktif yang dikembangkan sangat baik, berdasarkan uji keefektifan.

Kata Kunci: E-LKPD; ADDIE; *Liveworksheet*; *Problem Based Learning*; Kemampuan Pemecahan Masalah

Abstract
The purpose of this written research is to identify the features of interactive E-LKPD based on problem-based learning that have valid, practical, and effective properties in improving the mathematical problem solving ability of high school students in grade X on trigonometry material. The ADDIE development model is applied in the development of interactive E-LKPD through the utilization of the Liveworksheet website. The practicality test is carried out using UEQ (User Experience Questionnaire), the validity and suitability test of the media is carried out using the LORI assessment questionnaire, and the effectiveness test is carried out by assessing the completeness of the problem-solving ability test. The validity test of the material and the feasibility of the media uses the LORI assessment questionnaire, the practicality test of the material uses the UEQ , and the effectiveness test uses the completeness of the problem-solving ability test. The feasibility test of the material with very strict requirements. The feasibility test of the media has very high standards. The very good criteria for the practicality test are given to teachers and students of grade X of SMA Negeri 1 Tabanan including questionnaires in each area. The effectiveness of the interactive E-LKPD developed is very good, based on the effectiveness test.

Keyword*: E-LKPD; ADDIE; Liveworksheet, Problem Based Learning; Problem Solving Skill*

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INTRODUCTION

The rapid development of information and communication technology has brought about significant societal changes. Technological advancements have reached the era of Society 5.0 (Handayani & Muliastrini, 2020). This swift technological evolution demands that the education sector quickly adapt to the incorporation of technology in learning processes and media. Consequently, in this era, teachers play a crucial role in enhancing students' abilities as we transition into Society 5.0 (Ichsan et al., 2023).

According to (Santosa et al., 2021) "students must have 21st century skills in the context of society 5.0. Competencies that help a student master science and technology (IPTEK) to support the educational process are called 21st century skills" (Ichsan et al., 2023). To improve students' learning abilities, 21st century education requires the integration of technology as a learning medium (Rahayu et al., 2022).

Mathematics as one of the sciences that contributes to the advancement of science has been explained (Asrar et al., 2023). Mathematics is interpreted as one of the sciences that can teach humans to think critically, logically, and confidently. Trigonometry is interpreted as one of the high school mathematics subjects for grade X. Because this material is considered one of the most important subjects and is closely related to everyday life, this material is taught at the high school level. Every aspect of life cannot be separated from the application of trigonometry (Pitriana, 2022). Because many of the formulas and questions are difficult to explain, trigonometry is one of the mathematics subjects that is considered the most challenging for students (Mahdiana & Kahfi, 2021).

According to the results of interviews with mathematics teachers at SMA Negeri 1 Tabanan, students feel that trigonometry material is difficult because it is considered new material that has never been taught at previous levels of education. According to Nurdiyanto et al., (2019), "trigonometry is still a fairly difficult subject for some students because they prefer to memorize formulas rather than understand the subject matter. This is due to the limited concepts and knowledge of students or the difficulty in understanding the contents of the teaching material." Students are still taught using printed teaching materials which are usually in the form of formulas without an explanation of how to obtain them (Mahdiana & Kahfi, 2021)

One of the teaching materials that can support learning is the Student Worksheet (LKPD). According to Ermi, (2018), LKPD is defined as a teaching and learning tool that facilitates the teaching and learning process for teachers and students. In helping and guiding students in identifying concepts and solving problems, both individually and in groups, LKPD provides stages (Sabrina & Rahardi, 2021). Along with technological advances, teaching materials that were previously delivered in printed form are now delivered electronically. The electronic version of LKPD is known as E-LKPD.

(Puspita & Dewi, 2021) "stated that E-LKPD is seen as a student work guide designed with students easily understanding the information presented during the learning process using computers, laptops, and mobile phones." Liveworksheet is interpreted as one of the programs used in creating interactive E-LKPD. Liveworksheet is available online, offers a way to access resources and answer questions online, and has an automatic correction system that is already installed in the platform itself (Sudarman et al., 2022). Teachers can save time by using Interactive E-LKPD with Liveworksheet to check student work and reduce paper use, while students benefit from being motivated and more interactive, which increases their interest in learning (Widiyarsih et al., 2023). In addition, Prihandono et al., (2023) outlined the disadvantages of Interactive E-

LKPD, including students who are still used to it and are less able to concentrate because the learning stages do not provide enough direction in learning.

In line with that, the shortcomings of Interactive E-LKPD indicate that the focus of development is not on problem-solving skills and is limited in stimulating students' critical and analytical thinking when solving problems. The deficiencies of Interactive E-LKPD, as explained, demonstrate that the process of developing it must be based on a learning model aligned with the expected learning objectives. According to Bukhori (2018), "The learning model known as Problem Based Learning (PBL) is understood as one that enhances students' proficiency in solving mathematical problems. Problems serve as the foundation for PBL learning, which emphasizes student participation."

At SMA Negeri 1 Tabanan, the availability of gadgets and internet connections provides strong support for the implementation of PBL-based Interactive E-LKPD. Students learn to recognize and formulate problems to get the right solution through the implementation of PBL-based Interactive E-LKPD with Liveworksheet. Because it presents contextual problems and offers solutions to problems related to trigonometry, the selection of trigonometry material is in line with the PBL model. This is supported by the results of previous research by (Farman, Hali, F., & Rawal, 2021) "Interactive E-LKPD Liveworksheet is categorized as very valid and feasible when used, practical for use in learning, with an impact on student learning outcomes." In addition, research by Frica et al. (2022) regarding the effectiveness of PBL-based E-LKPD found that in the initial and final tests, student learning outcomes obtained a value of 0.7 which is included in the high category. To ensure the effectiveness of developing PBL-based E-LKPD in the education process.

Another study conducted by Asrar et al., (2023) produced an E-LKPD based on the PBL model that was quite valid, efficient, and effective. Widiyarsih et al., (2023) also produced an E-LKPD assisted by Liveworksheet that was valid, efficient, and effective. Research conducted by Faidah, Faidah et al., (2023) shared the results of using a learning media assisted by Liveworksheet that affected cognitive learning outcomes in students. (Wulansari, 2022) in her research produced an effective PBL-based E-LKPD and was used as a reference in developing learning media to improve problem-solving skills. Research conducted by Munika et al., (2021) also produced an E-LKPD developed based on the PBL model that was quite valid, efficient, and effective, and was able to improve problem-solving skills. (Astuti, 2021) in her research produced a PBL-based LKPD as a material for developing learning models.

According to the problems described and various relevant previous studies, developing interactive E-LKPD based on PBL needs to be done. The purpose of the written research is to develop and determine the characteristics of valid, practical, and effective PBL-based Interactive E-LKPD in improving students' mathematical problem-solving abilities in trigonometry material for grade X of high school.

METHODS

The type of research carried out is R&D (Research and Development) development research. R&D is a procedure for creating a product or perfecting an existing product so that it can be accounted for (Muqdamien et al., 2021). Implementation of research from the development of E-LKPD based on Problem Based Learning with several learning media development procedures. The research flow is written in the ADDIE model, including: "Analysis, Design, Development, Implementation, Evaluation." The products in the E-LKPD development research are studied only in terms of content validity, feasibility, effectiveness, or practicality.

At the analysis stage, the activities carried out are analyzing the problems and requirements for developing learning media which include observation of conditions, learning facilities, teacher observation, and observation of student needs. The analysis stage is curriculum analysis, analysis of student characteristics, material analysis, and formulation of learning objectives. Analysis of the curriculum is carried out by reviewing the curriculum applied in target schools for grade X students, namely the Independent Curriculum. The curriculum review aims to determine learning outcomes. Student behavior and personality are then known through analysis of student characteristics, considering that the learning process is always modified according to the circumstances and personalities of students. Material analysis aims to determine important concepts that students need to understand and related materials that must be learned. Initially, the material to be studied in E-LKPD is identified, and then organized. In addition, following the curriculum and material analysis, activities are carried out by compiling learning objectives, which ensure that the material in E-LKPD is developed without deviating from the learning objectives that must be achieved.

In the design stage, the activities are carried out by designing media according to the results of the analysis stage. The design stage consists of selecting a media, selecting a format, and compiling an initial design. The media selection is based on the determined material and the intended learning objectives. The format selection is based on the determined material and the media used. The layout, images, videos, and writing of the LKPD are all included in the LKPD format. The LKPD format is compiled according to the standards used in its creation, especially the use of Problem Based Learning by improving students' ability to solve problems in mathematics. After the media and format selection process, the next step is to create an initial draft of the E-LKPD, which includes a general description and a description of the content formed.

In the development stage, the activities carried out are the development of the initial product of E-LKPD based on Problem Based Learning and the validation stage with experts. The development stage consists of developing the initial product design, expert assessment (material expert validation and media expert assessment), individual and small group trials, and practicality tests. The initial design on the storyboard that has been prepared is then developed into an initial product in the form of E-LKPD based on Problem Based Learning in the Liveworksheets application and other supporting software. Expert assessment in this stage means experts in the field of material, namely expert lecturers in the field of Mathematics at Ganesha University of Education and Mathematics Teachers. While experts in the field of media and learning design, namely expert lecturers in the field of Mathematics and Educational Technology at Ganesha University of Education. The validity test of the material along with the feasibility of a media is carried out in the LORI (Learning Object Review) assessment questionnaire. After the data is collected and analyzed, the results of the analysis are then converted into a media feasibility scale in table 1.

Table 1. Media Eligibility Criteria

Percentage (%)	Explanation
$4{,}20 \leq \bar{X} \leq 5{,}00$	Very Agree
$3{,}40 \leq \bar{X} < 4{,}20$	Agree
$2{,}60 \leq \bar{X} < 3{,}40$	Neutral
$1{,}80 \leq \bar{X} < 2{,}60$	Disagree
$1{,}00 \leq \bar{X} < 1{,}80$	Strongly Disagree

Before the limited trial, the interactive E-LKPD will be evaluated from an individual trial of 3 people and then a small group trial of 9 people. Furthermore, a practicality test is carried out in the UEQ (User Experience Questionnaire) questionnaire. The assessment of the UEQ questionnaire

includes 26 questions covering six aspects, namely "attractiveness, efficiency, clarity (Perspicuity), accuracy (dependability), stimulation (stimulation), and novelty (novelty)." After the data is collected and analyzed, the results of the analysis are then converted into a media practicality scale in Table 2.

Table 2. Media Practicality Criteria

Aspect	Level of Practicality				
	Excellent	***Good***	***Above Average***	***Below Average***	***Bad***
Attractiveness	$\bar{X} \geq 1{,}75$	$1{,}52 \leq \bar{X} < 1{,}75$	$1{,}17 \leq \bar{X} < 1{,}52$	$0{,}7 \leq \bar{X} < 1{,}17$	$\bar{X} \leq 0{,}7$
Perspicuity	$\bar{X} \geq 1{,}9$	$1{,}56 \leq \bar{X} < 1{,}9$	$1{,}08 \leq \bar{X} < 1{,}56$	$0{,}64 \leq \bar{X} < 1{,}08$	$\bar{X} \leq 0{,}64$
Efficiency	$\bar{X} \geq 1{,}78$	$1{,}47 \leq \bar{X} < 1{,}78$	$0{,}98 \leq \bar{X} < 1{,}47$	$0{,}54 \leq \bar{X} < 0{,}98$	$\bar{X} \leq 0{,}54$
Dependability	$\bar{X} \geq 1{,}65$	$1{,}48 \leq \bar{X} < 1{,}65$	$1{,}14 \leq \bar{X} < 1{,}48$	$0{,}78 \leq \bar{X} < 1{,}14$	$\bar{X} \leq 0{,}78$
Stimulation	$\bar{X} \geq 1{,}55$	$1{,}31 \leq \bar{X} < 1{,}55$	$0{,}99 \leq \bar{X} < 1{,}31$	$0{,}5 \leq \bar{X} < 0{,}99$	$\bar{X} \leq 0{,}5$
Novelty	$\bar{X} \geq 1{,}4$	$1{,}05 \leq \bar{X} < 1{,}4$	$0{,}71 \leq \bar{X} < 1{,}05$	$0{,}3 \leq \bar{X} < 0{,}71$	$\bar{X} \leq 0{,}3$

In the implementation stage, after the media is declared valid and feasible, the activities carried out are media implementation through limited trials in the target class, namely class X11 with 48 students. After the limited trial is carried out in the target class, the activity is continued by giving a problem-solving ability test to determine the effectiveness of the E-LKPD that has been developed. The effectiveness test is carried out to assess the completeness of the problem-solving ability test, namely 5 descriptive questions.

In seeing the completeness of the student's test results on trigonometry material, the effectiveness of this E-LKPD can be evaluated. Each question item is processed and analyzed to determine the student's score. The students' test results are then collected to calculate the percentage of test completion based on the Learning Completion Criteria (KKTP). For trigonometry material for tenth-grade SMA, this interactive E-LKPD based on problem based learning is said to be effective in improving students' mathematical problem solving abilities. If the range of student completion is in the range of 60% < X < 80%, the completion is categorized as Good.

At the evaluation stage, it is interpreted as the last stage of the ADDIE model. Evaluation in the development research is limited to formative evaluation by including validation from material or media experts. The results of this evaluation will be used as a consideration for researchers to revise the media being developed.

RESULT

Written research has succeeded in developing an Interactive E-LKPD based on problem-based learning by improving mathematical problem-solving skills in students in trigonometry material in grade X of high school. This E-LKPD contains trigonometry material that refers to the independent curriculum. This E-LKPD can be accessed by students with smartphones, notebooks, PCs, or laptops by accessing the website www.liveworksheets.com.

In the development of this E-LKPD product, several supporting applications are used. The applications used include Microsoft Word used to compile materials in E-LKPD. Liveworksheets is used to create Interactive E-LKPD, Canva is used for editing designs on E-LKPD, YouTube is used to upload learning videos, and Geogebra is used as a means of exploring special angles in trigonometry.

The structure of E-LKPD consists of a cover page, an opening page, and an activity page that covers three topics. The three topics include naming sides and trigonometric ratios in right triangles, special trigonometric angles, and the application of a trigonometric ratio to solve

mathematical problems. The following is an example of the display of the interactive E-LKPD product that has been developed.

Figure 1. Activity Page View

On the activity page there are five phases of learning according to the syntax in the problem based learning model, namely; student orientation to the problem, organizing students in learning, guiding in individual/group investigations, developing and presenting the results of work, analyzing or evaluating a process of problem solving. In Figure 1, an example of a display of learning activities in phase 1 is interpreted, where participants are given a video of the problem and then collect the information obtained in phase 2. Furthermore, students will continue learning activities in phase 3 to find solutions or resolutions to the assigned problems as shown in Figure 2, namely.

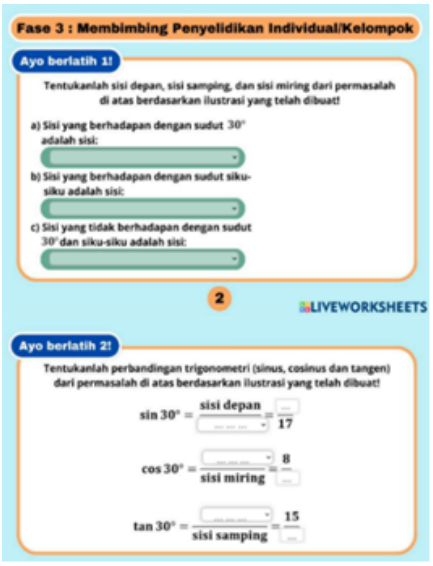

Figure 2. Activity Page View in Phase 3

In phase 3, students are instructed to determine the solution to the problem requested in the video by utilizing all the information collected in the previous phase. The solution steps in this interactive E-LKPD can be implemented with various types of answering methods such as fill-in, multiple choice, matching, check box, and drag and drop so that learning activities are more interactive and interesting.

Table 3. Recapitulation of Material Expert Assessment Results

Item Number	Score	Expert 1	Expert 2
A1	5	5	5
A2	5	5	5
A3	5	5	5
A4	5	5	5
B1	5	5	5
B2	5	5	5
B3	5	5	5
B4	5	5	4
C1	5	4	5
D1	5	5	5
Total Score		**49**	**49**
Maximum Score		**50**	**50**
Average Score		**4,9**	**4,9**
Total Average		**4,9**	
Percentage		**98%**	**98%**

According to the results of the material validity test from the experts in Table 3, an average total material validity of 4.9 was obtained with a percentage of 98%.

Table 4. Recapitulation of Media Expert Assessment Results

Item Number	Score	Expert 1	Expert 2
A1	5	5	5
B1	5	5	5
B2	5	5	5
B3	5	5	5
C1	5	5	5
C2	5	5	5
D1	5	5	4
E1	5	4	4
Total Score		**39**	**38**
Maximum Score		**40**	**40**
Average Score		**4,87**	**4,75**
Total Average		**4,81**	
Percentage		**97,5%**	**95%**

According to the results of media validity from experts in Table 4, the average media validity was 4.81 with a percentage of 96.25%.

Table 5. Summary of Teacher Response Questionnaire Analysis Results

Aspect	Average	Category
Attractivenes	2,50	*Excellent*
Perspicuity	2,20	*Excellent*
Efficiency	2,75	*Excellent*
Dependability	2,75	*Excellent*
Stimulation	3,00	*Excellent*
Novelty	2,63	*Excellent*

After the E-LKPD is declared valid and feasible through expert assessment, the E-LKPD is ready to be tested on individuals and small groups. In the individual trial, the E-LKPD was tested on 3 students, then in the small group trial, it was tested on 9 students of SMA Negeri 1 Tabanan

outside of the students in the class that will be used for limited trials. When conducting individual trials or small group trials, no obstacles were found in its implementation. This shows that the E-LKPD was developed and can be tested in class or limited trials.

According to the practicality analysis measured through a response questionnaire from 2 mathematics subject teachers in Table 5, overall it was found that the Interactive E-LKPD developed had practicality with excellent criteria.

Table 6. Summary of Student Response Questionnaire Analysis Results

Aspect	Average	Category
Attractivenes	2,33	*Excellent*
Perspicuity	2,17	*Excellent*
Efficiency	2,13	*Excellent*
Dependability	2,15	*Excellent*
Stimulation	2,46	*Excellent*
Novelty	1,88	*Excellent*

According to the practicality analysis measured through a questionnaire response from 12 students in Table 6, overall it was found that the Interactive E-LKPD developed had practicality with excellent criteria.

The effectiveness of Interactive E-LKPD is measured by distributing problem-solving ability tests to 48 students after E-LKPD is used in learning. The test consists of 5 descriptive questions to measure students' problem-solving abilities in trigonometry material. The results of the effectiveness test are in the form of student test scores in Table 7.

Table 7. Descriptive Analysis Results

N	Min	Max	Median	Modus	Mean	Stdev
48	66	96	88	88	85,0833	8,52

The results of the student's test scores are then analyzed and summarized to find out which students have test scores above the KKTP. According to the summary of the results of the effectiveness of the Interactive E-LKPD in table 7, all students achieved the KKTP in a percentage of 93.75% of the very good criteria.

DISCUSSION

Interactive E-LKPD based on problem based learning E-LKPD emphasizes problem-based learning activities as the basis for learning, which is interpreted as one of the five characteristics of written research developed to improve students' mathematical problem-solving abilities in trigonometry material for grade X of high school, E-LKPD adapts its learning phase with the syntax of the problem-based learning model by helping students solve a problem. E-LKPD was created by requiring students to actively construct their knowledge through the stages in each phase of learning. The problem-solving procedure in each phase of learning is interactive and offers a variety of answer choices. To perfect its appearance and increase student motivation in learning through problem solving, E-LKPD was created using the Liveworksheet website which can be accessed online. In line with (Susanti et al., 2019), PBL is able to improve problem-solving abilities because students are actively involved in the process or obtaining results from solving a problem. In line with Dewi & Parwati, (2020), learning with PBL is expected to be able to create more meaningful learning and share a strong impression with students.

The E-LKPD can be developed in written research with the Liveworksheet website as a development medium. In line with the research conducted by Teresa et al., (2022), E-LKPD assisted by Liveworksheet is effective in the learning process because it can present images, videos, audio and various types of ways to answer questions that make this E-LKPD more

interesting for students. This is in line with the research (Zahroh & Yuliani, 2021) that the E-LKPD developed with the help of Liveworksheet is packaged in the form of electronic worksheets that can be filled in directly by students and supported by images, videos, and audio so that the learning process becomes more interesting and interactive. In line with the results of Munawaroh's research, (2022), "which states that interactive learning media can increase learning motivation in students and help students understand the material, especially trigonometry material."

The interactive E-LKPD was developed by researchers adopting a visual-auditorial learning style by integrating videos in presenting problems in the learning phase. In phase 1 (student orientation to the problem), students are directed to observe the problems available in the video as a basis for being able to teach learning activities in the next phase. According to research by Fridayanti et al., (2022), "audio-visual learning media can make it easier for students to understand learning material with text, images, sound or animation that can provide stimulation to students through their hearing and sight." In line with Arya Arimbawa et al., (2024), the use of visual media can facilitate understanding and sharpen students' memory of the material being studied. This is supported by what was concluded by (Yusnidah & Taruna, 2021) namely that student learning outcomes in using audio-visual learning media are better than visual learning media and audio-visual is very appropriate for use in electronic learning media.

The material compiled in E-LKPD consists of three main topics of material where each topic consists of five learning activities. The five activities in E-LKPD are developed referring to the learning phases with PBL syntax. In phase 1 (student orientation in the problem), students are instructed to watch a video containing a problem related to the topic of the material in the learning activity. The problem video is interpreted as the basis for students to be able to continue learning to the next phase, because it contains information for solving the assigned problem. In phase 2 (organizing students to learn), students are instructed to explore and collect information in the problem video related to things that are known or unknown with things that are questions or problems that must be resolved or have solutions determined.

In phase 3 (guiding individual/group investigations), students are instructed to determine the solution to the problem requested in the video by utilizing all the information collected in the previous phase. The solution steps in this interactive E-LKPD can be carried out in various ways of answering such as filling in, multiple choice, matching, check box, and drag and drop. In phase 4 (developing and presenting a work), students are instructed to present their work in front of the class and compare their work with their friends. If there are differences in results between students, the educator will share feedback and reflections with students. In phase 5 (analyzing and evaluating the problem-solving process), students are instructed to analyze and evaluate the learning activities carried out from the first phase to the last phase, and are asked to convey things they want to ask if there are still things that are not understood with the topic of the material discussed. After that, students will be asked to conclude the results of the learning activities that have been carried out.

The validity test of the material on the Interactive E-LKPD was developed by two experts, one lecturer from the Mathematics Department of Ganesha University of Education and one mathematics teacher at SMA Negeri 1 Tabanan. According to the results of the material validation questionnaire analysis in table 3, it was found that the E-LKPD developed was valid in the average total material validity score of 4.9 with a percentage of 98%. The validity of the material includes aspects of material quality, learning objectives, feedback, and adaptation, or motivation. According to the results of the material expert assessment, the E-LKPD was declared feasible to be tested.

The media validity test on the Interactive E-LKPD was developed by two experts, one lecturer from the Mathematics Department and one lecturer from Educational Technology, Ganesha University of Education. According to the results of the media validation questionnaire analysis in table 4, it was found that the interactive E-LKPD developed was valid with an average media validity score of 4.81 with a percentage of 96.25%. Media validity includes aspects of presentation design, usage interaction, accessibility, reuse, and meeting standards. According to the results of the media expert assessment, this interactive E-LKPD was declared worthy of being tested.

The practicality test of the Interactive E-LKPD was carried out at the development stage. Before testing the practicality, an individual trial was carried out on 3 students and a small group trial was carried out on 9 students in class X of SMA Negeri 1 Tabanan. After the trial process of the Interactive E-LKPD was carried out with individuals and small groups, a practicality test was carried out by giving a response questionnaire to 2 mathematics teachers and 12 students. Reviewing the results of the analysis carried out, from the teacher response questionnaire in table 5, the overall score of the Interactive E-LKPD developed has practicality with excellent criteria. Furthermore, for the results of the student response questionnaire in table 6, the overall score of the Interactive E-LKPD developed has practicality with excellent criteria.

The implementation of Interactive E-LKPD in the classroom was carried out for 48 students in class X11 of SMA Negeri 1 Tabanan offline for 3 meetings. In phase 1, students were instructed to watch a video containing a problem related to the topic of the material in the learning activity. After watching the video, students then continued the learning activities in phase 2. In this phase, students were instructed to explore and collect information available in the problem video related to things that need to be known or things that have never been known and things that become questions or problems that must be resolved or have solutions determined. After collecting all the information, students then continued the activities in phase 3. In this phase, students were instructed to determine the solution to the problem requested in the video by utilizing all the information that had been collected in the previous phase. After getting a solution to the problem, students then continued the activities in phase 4. In this phase, students were instructed to present their work results in front of the class and compare their work results with their friends. If there are differences in results between students, educators will share feedback and reflections with students. The last phase of E-LKPD is phase 5, students are instructed to analyze and evaluate learning activities that have been carried out from the first phase to the last phase and are asked to conclude the results of learning activities that have been carried out.

After conducting a limited trial in class to 48 students, an effectiveness test was then conducted to determine whether the Interactive E-LKPD media could improve students' mathematical problem-solving abilities with trigonometry material. The effectiveness test was conducted by distributing problem-solving ability tests at the end of the learning activity after completing the E-LKPD. The students' test scores were analyzed, then the number of students who scored above the KKTP was calculated. According to the results of the effectiveness test in table 7, the effectiveness of the PBL-based Interactive E-LKPD in improving mathematical problem-solving abilities in trigonometry material for grade X of this high school has a very good category in the percentage of student completion of 93.75%.

Interactive E-LKPD that has been developed in written research with advantages and disadvantages. The advantages of the E-LKPD that was developed include; (1) Interactive E-LKPD is compiled based on a problem-based learning model aimed at helping students solve mathematical problems, (2) Interactive E-LKPD contains text, video, images and various types of

answering methods so that learning activities become more interactive and interesting, (3) Interactive E-LKPD is able to facilitate students in constructing their understanding independently so that learning is centered on students, and (4) Interactive E-LKPD can be operated on desktop electronic devices such as smartphones, notebooks, PCs, or laptops. While the disadvantages of this Interactive E-LKPD are; (1) Requires an internet network to be able to access E-LKPD, (2) Interactive E-LKPD can only share feedback to students in the form of final grades, correct and incorrect answers, cannot share feedback in the form of discussions for correct answers, and (3) In filling in answers for descriptive questions, it cannot be done with mathematical symbols.

CONCLUSION

Interactive E-LKPD based on problem based learning has been developed, able to meet valid, practical, and effective standards. Interactive E-LKPD in written research has five features: E-LKPD emphasizes problem-based learning activities as the basis for learning, E-LKPD adapts the learning phase in the syntax of the problem-based learning model by helping students solve problems. According to E-LKPD, students must actively build their knowledge with the stages in each phase of learning. The problem-solving procedure for each phase of learning is interactive and offers some answer choices. In order for E-LKPD to look more attractive and increase students' motivation to learn and solve problems, E-LKPD was created with the Liveworksheet website which can be accessed online. The results of the analysis of the validity test of the material percentage of 98%, the results of the media expert assessment with a percentage of 96.25%, the results of practicality in the six aspects with excellent criteria, and student completeness of 93.75% in the category of very good effectiveness. From the results obtained, the interactive E-LKPD based on PBL can improve students' mathematical problem solving abilities in trigonometry material. Furthermore, this Interactive E-LKPD can be used as an alternative in learning media in the learning process, especially trigonometry material. For further research, because the Interactive E-LKPD was developed to only contain trigonometry material, it is hoped that development can be carried out in other materials and on different subjects and samples. In addition, this Interactive E-LKPD is assisted by Liveworksheet which cannot yet contain mathematical symbols in the descriptive answer type, so it is hoped that further researchers can provide an objective type of answer or add a link for students to upload their answers in the form of images.

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