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Development of Desmos Application Design Integrated PBL Assisted Liveworksheet Based on Mathematical Literacy in AKM Preperation Efforts

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Abstract: This research aims to develop a learning media using Desmos application integrated with PBL (Problem-Based Learning) assisted by live worksheets based on mathematical literacy in preparation for AKM (Minimum Competency Assessment); and determine the feasibility and practicality of the learning media using Desmos application integrated with PBL assisted by live worksheets based on mathematical literacy in preparation for AKM. The research method used is Research and Development with ADDIE models. The research instrument uses a rating scale for media experts, material experts, practitioners, and students. The results of the development of learning media on quadratic equations obtained a percentage of 95.45% with a very valid category from media experts. Material experts gave a percentage of 93.33% with a very valid category. Practitioners gave a percentage of 94.37% with a very practical category. The results of small group trials of students were declared fit for use, and the results of large group trials obtained a percentage of 39.29% strongly agreed and 57.14% agreed to be interested when using Desmos application media assisted by live worksheets. From the results of the research, the learning media developed is very valid and practical to be used in mathematics learning based on expert validation.

Keywords: Desmos; Liveworksheet; Mathematics literacy; Minimum competency assessment; PBL

Introduction

The rapid advancement of technology at this time affects the development of education. The curriculum in Indonesia continues to adapt to the development of science and technological innovation in accordance with the needs of students in this era. Various technological innovations that develop can be used wisely to improve the quality of education. Therefore, the utilization of information technology in the learning process is a must (Ulyatin et al., 2023). The use of technology by teachers as a learning medium supports the development of students' mathematical literacy, which is one of the abilities that must be possessed in facing the technological era 5.0 (Nuri et al., 2023; Ramadhan et al., 2023).

Mathematical literacy is the ability to formulate, use and interpret mathematics in various contexts of daily life problems efficiently (Kurniasari et al., 2023). Learners are not only skilled at counting but are able to think mathematically in analyzing, evaluating and drawing conclusions on the basis of logical, rational and critical thinking about a problem. Mathematical literacy helps learners understand the functions, concepts and applications of mathematics in everyday life and use

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them in solving problems correctly (Adlina et al., 2024; Dewi & Maulida, 2023; Hayati & Kamid, 2019).

The world of education, especially mathematics in Indonesia is currently undergoing a significant transformation. The emergence of the Minimum Competency Assessment (MCA) marks a paradigm shift in assessment from just memorizing formulas to the ability to think critically, solve problems, and apply mathematical concepts in everyday life. However, the reality on the ground shows that many students still have difficulties in understanding mathematical concepts deeply and applying them in different contexts. The concept of mathematical literacy states the importance of learners developing a good understanding of mathematical concepts and the benefits of mathematical engagement in the real world. Mathematical literacy is also in line with the goals of education for sustainable development (Chen et al., 2022) and is important in school curricula and sustainable education decisions (Holenstein et al., 2021).

Mathematical literacy is one of the assessments in the Minimum Competency Assessment (MCA) and one of the three PISA 2022 mathematics assessment frameworks. AKM contains a variety of problems for learners to solve using reading literacy and mathematical literacy skills (Zahrudin et al., 2021). Learners who have a good understanding of mathematical literacy do not just understand mathematical concepts, but are able to apply them in solving everyday problems (Yildirim & Sidekli, 2018), because learners' thoughts and actions are the result of culture and ways of thinking and acting based on experience (Minarni & Barus, 2023).

Mathematical literacy can be developed and honed by teachers during learning through innovative mathematical learning (Ramadhan et al., 2023). However, mathematical literacy has not received attention by both students and teachers (Kholid et al., 2022). Learners have difficulty in mathematizing a problem, this is because the teacher does not direct students to mathematize (Kholid et al., 2022) so that the emergence of thoughts from students that mathematics is rarely used in everyday life (Bolstad, 2023). In addition, when viewed from the results of the PISA assessment, the level of mathematical lieration ability of students is at the second level (Kusuma et al., 2022).

Low mathematical literacy skills are caused by the lack of students ability to think critically about the problems they face (Maslihah et al., 2020; Rizki & Priatna, 2019; Sukestiyarno et al., 2019). This can also happen because of the learning model used by the teacher. Most teachers in schools only utilize simple learning media, such as whiteboards, printed books and projectors as presentations in the learning process (Habibi & Suparman, 2020). The solution to this problem is to train thinking skills through appropriate and innovative learning models (Maskur et al., 2020; Paloloang et al., 2020; Harahap, 2020) and familiarizing students to solve questions with PISA characteristics (Oktaviranda & Asmara, 2021). This can be pursued by developing application design as a technology-based learning media integrated with PBL to facilitate students' mathematical literacy skills.

PBL was chosen referring to various studies regarding the effectiveness of PBL in achieving problem solving and mathematical literacy skills. (Amalia et al., 2021; Maskur et al., 2020; Tambunan, 2019). In addition, the utilization of technology in education as a learning tool provides a richer learning experience (Sima et al., 2022) and fun to learners (David & Weinstein, 2024). Integrating technology as a learning medium can also affect the success of mathematics learning (Nuri, 2019). Learning media helps students understand the basic concepts of mathematics because learning mathematics is not only being able to memorize various formulas but understanding the basic concepts of a formula and being able to use mathematical concepts in everyday life (Wijaya et al., 2020). Learning media that can be used in the form of desmos applications that are integrated with PBL and combined with liveworksheets.

Desmos is seen as one of the technologies that has great potential in improving the quality of mathematics learning (Attard & Holmes, 2022; Meyer, 2020; King, 2017; Orr, 2017). The visualization component in the Desmos application further helps students in understanding the material well. The use of Desmos in the classroom can be done in two ways: by learners and by the teacher (Machado et al., 2023). Desmos provides students with the opportunity to perform, analyze, visualize mathematical concepts and their applications while studying functions because it allows users to draw graphs and explore their characteristics (Chorney, 2022; Chechan et al., 2023).

The design of the Desmos application can be combined with liveworksheets to maximize learners in working on mathematical literacy-based problems. Several studies that have been described previously state that the desmos application design and liveworksheet in the context of PBL in mathematics learning offers a more effective, interesting and learner-centered learning approach because it has advantages including better visualization of mathematical concepts, interactive learning, increased understanding of concepts, increased learning motivation and time efficiency. The results of the study by Chechan et al. (2023), showed that the use of desmos has a positive impact on students' understanding of the concept of functions, the ability to analyze functions and check their answers through visualizations which are difficult to do when using paper and pencil. Likewise, Karindra et al. (2022), stated that digital LKPD based on the desmos application is an alternative media that can develop students' skills. The use of liveworksheet can help improve learners' cognitive abilities (Felitasari & Rusmini, 2022), mastery of concepts and train teamwork to solve problems (Husna et al., 2020). The use of PBL liveworksheet has a quite relevant effect on learning (Pertiwi & Kadarisma, 2023). Increasing mathematical literacy skills can be achieved by implementing PBL-based mathematics learning (Pamungkas & Franita, 2019).

The problem is that Desmos is one of the tools that has not been widely integrated into mathematics learning even though it is considered the easiest to use (Chorney, 2022). Likewise with the Desmos application assisted by Liveworksheet. The results of the analysis show that there has been no research that has developed a PBL-integrated Desmos application design assisted by Liveworksheet based on mathematical literacy. This is important to do because mathematical literacy is one of the assessments in the Minimum Competency Assessment (AKM) in accordance with government policy. Based on this explanation, it is necessary to develop a desmos application design integrated with PBL assisted by liveworksheet based on mathematical literacy in an effort to prepare for AKM. This research aims to develop learning media using desmos application integrated PBL assisted liveworksheet based on mathematical literacy in AKM preparation efforts that are feasible and practical to use for class X SMA students on quadratic equation material.

Method

The method used in this research is development research (Research & Development) with the ADDIE development model. This research was conducted to develop a desmos application design integrated with PBL and combined with a mathematical literacy-based liveworksheet. The development of this desmos application design contains material that is presented audio-visually, then there is a liveworksheet containing mathematical literacy-based questions provided as a place to train students' literacy skills. The material used is quadratic function material at Senior High School (SMA) and has a close relationship with mathematical literacy skills questions tested on the AKM national assessment. The material will be taught in the PBL integrated desmos application and assisted by liveworksheet.

Development Procedure

The ADDIE development model consists of 5 stages which are then modified into 4 stages, namely Analysis, Design, Development, and evaluating the final product. At the analysis stage, the needs of learning media development were analyzed by conducting initial observations of students and teachers on the subject of quadratic equations. The data obtained is used to design desmos application media assisted by liveworksheet on learning quadratic equations. In the design stage or design of learning media, the design of desmos application media assisted by liveworksheet is carried out which includes determining the elements that need to be included in the media developed in accordance with the aspects of the teaching content to be carried out. At the development stage, the following were carried out development of learning media design by selecting appropriate images, compiling images in accordance with the layout and design of the material, and quizzes; development of the appearance and content of material on learning media using desmos application media assisted by liveworksheet arranged systematically in accordance with predetermined learning strategies; making media feasibility test instruments; validation and product feasibility testing by two media experts and two material experts and 4 practitioners; and product revision if there are corrections. In the final stage, namely the evaluation stage,testing was carried out on students which was carried out in 2 stages, namely small group trials and large group trials. This trial by students is to assess the feasibility level of the developed media.

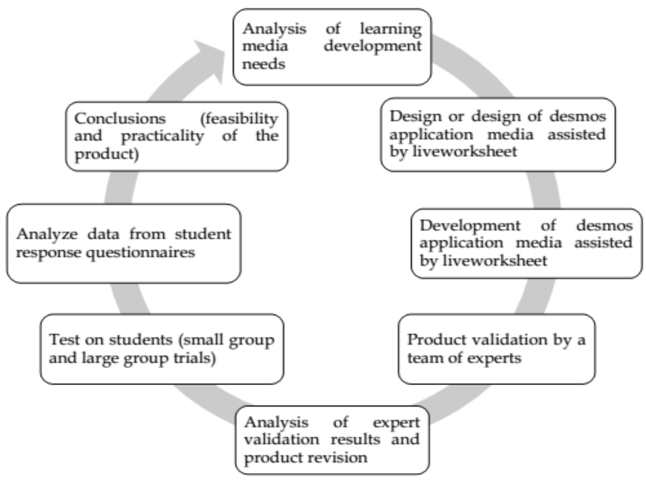

Figure 1. The research flow

Test Subjects

This research was conducted at SMAN 3 Bireuen Regency. Small group trials with the number of subjects 6 students and large group trials with the number of subjects 28 students.

Data Collection Technique

The product validity instrument developed in the form of a validity questionnaire assessed by material/media experts and mathematics teachers. The practicality instrument developed in the form of a student response questionnaire which is used to determine the practicality of the desmos application design product and liveworksheet. The data collection technique used is observation, researchers make direct observations starting from the beginning before product development is carried out. Expert validation, validation is carried out to determine the feasibility of the product developed. Furthermore, the response questionnaire was given to mathematics teachers and students to assess the practicality of the products developed.

Data Analysis Technique

Data analysis was carried out by processing data on validator responses and student response questionnaires with a Likert scale.

Result and Discussion

The development of this teaching material follows the ADDIE model which includes analysis, design, development, and evaluation stages. At the analysis stage, researchers explore information related to current observation of the learning process. The observation results show that students have difficulty in mathematizing a problem, so students assume that mathematics is rarely used in everyday life. Based on this problem, interactive media is needed that displays the process of solving contextual problems (formulating, using and interpreting) that can be solved mathematically. Desmos application can be used to support mathematics learning media that recommends various types of facilities to support learning mathematics (Ramadhani et al., 2022).

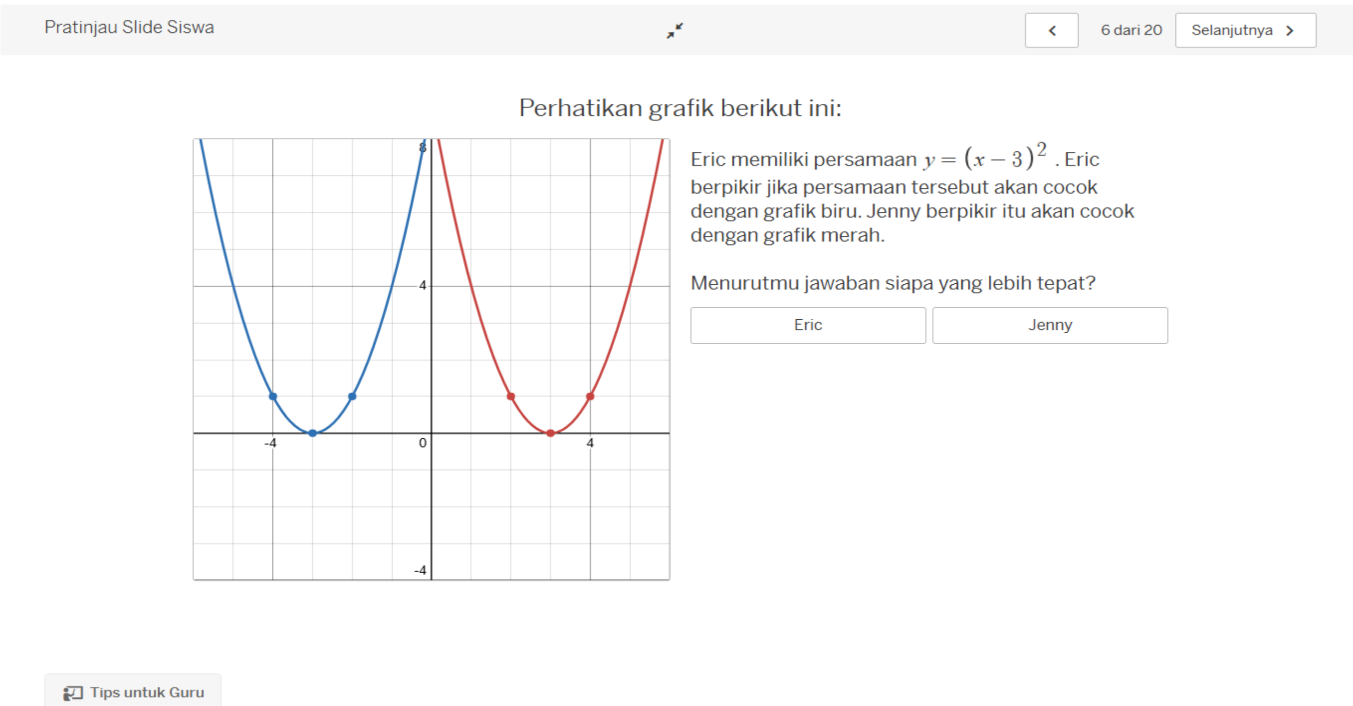

Figure 2. Excerpt of desmos teaching materials assisted with liveworksheet

The second stage of the ADDIE model is the design stage. The design stage is related to research design (Fuadi et al., 2022). At this stage, the desmos application is designed as a liveworksheet-assisted learning media on the quadratic equation material. This media will later introduce students to the fact that digital technology can be utilized as one of the mathematics learning media that can help them solve math problems related to how to draw function graphs (Kristanto, 2021). Therefore, the teaching materials prepared are adjusted to the subject matter of the material in the form of an instruction manual for using the desmos application assisted by liveworksheet starting from the initial steps of introducing the application to solving problems using desmos. The design of the desmos application combined with liveworksheet aims to maximize students in working on mathematical literacy-based problems. The use of this liveworksheet as an innovative learning media that can enhance the learning experience (Defira et al., 2024). In addition, this liveworksheet will later help teachers turn printed worksheets into interactive online exercises that can correct automatically (Firdaus et al., 2024; Saputra et al., 2024). Design of the Desmos application assisted by liveworksheet integrated with the PBL model facilitates students to be actively involved in solving real problems related to mathematical concepts. Multimedia is made based on the PBL model where students are given problems at the beginning of learning, then organize students to learn, conduct investigations, develop and present work results and are able to analyze and evaluate the problem-solving process (Adhana & Andriani, 2024). Problems in everyday life can be a memorable problem context and attract students' interest to explore them (Rafidah et al., 2024).

In the development stage, the media that has been designed and then designed into a product in the form of a liveworksheet-assisted desmos application. Then, the media is validated by media experts and material experts. Validation is carried out to determine the feasibility of learning media that has been developed. Suggestions and comments from experts will be used as a reference to make improvements so that the media developed is suitable for testing in the field. The results of validation by media experts and material experts are presented in Table 1.

Table 1. Results of Expert Validation

Aspect Assessed	Percentage	Qualification
Media	95.45%	Very valid
Material	93.33%	Very valid
Average	94.39%	Very valid

Based on Table 1, it can be seen that the desmos application media assisted by liveworksheet is very valid with a percentage of each including the media aspect 95.45% with a very valid category, and the material aspect 93.33% with a very valid category. This shows that the development of media design in the liveworksheet- assisted desmos application can be used by students with the suggested improvements.

The practicality of the desmos application learning media assisted by liveworksheet can be known through the results of practitioner validation. The validation data obtained from practitioners is used to assess the practicality of the media before being tested in the field.

Table 2. Results of Validation by Practitioners

Validator	Percentage	Qualification
Practitioner 1	85%	Very practical
Practitioner 2	96.67%	Very practical
Practitioner 3	98.33%	Very practical
Practitioner 4	97.5%	Very practical
Average	94.37%	Very practical

Based on the results of the questionnaire analysis in Table 2, it can be concluded that the desmos application media design assisted by liveworksheet is very practical for use in learning activities. The valid product was then carried out a small-scale trial involving 6 (six) students. The learners involved previously considered the representation of each high, medium and low ability. Learners are invited to use the product in order to get to know and carry out learning activities with the desmos application assisted by liveworksheet. The results of the interest test using the desmos application media assisted by liveworksheet can be seen in Figure 3.

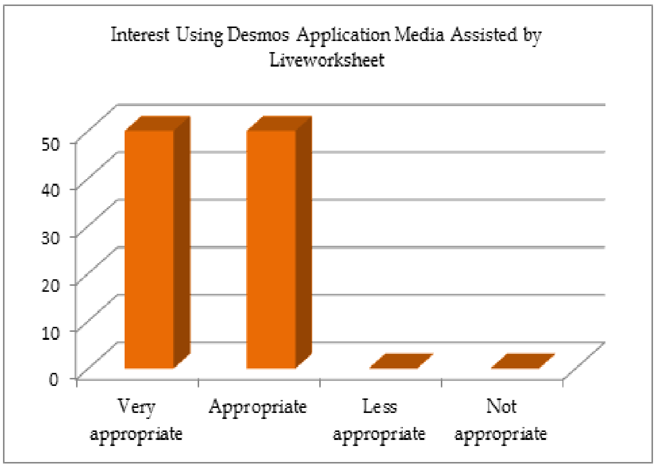

Figure 3. Graph of interest in using desmos application media assisted with liveworksheet

The results of questionnaire analysis in the small group trial showed that 50% of students strongly agreed and 50% agreed with the use of desmos application media assisted by liveworksheet (Figure 3). According to students, Desmos application media assisted by liveworksheet is interesting to use in the learning process. Desmos has a class activity facility, where teachers can design their own learning so that it is more flexible and interesting. Teachers can include appropriate images or videos to support the teaching material. This media is very helpful for teachers in describing abstract topics in the form of graphics to students so that the learning process becomes more useful. The media used in learning must provide benefits and increase absorption of the material because the more attractive the appearance, the higher the interest in learning of students (Elci et al., 2021).

The small group trial consisted of class X students at SMAN 3 Bireuen. The purpose of this trial was to determine the feasibility of using the development of media design in the desmos application assisted by liveworksheet so that it could be implemented in the field trial of 28 respondents. The results of observations of small groups are presented in Table 3. Based on the observation results, it was found that the media developed was feasible to use based on several indicators related to the applicability, ease of use, learning materials/activities and appearance of the liveworksheet-assisted Desmos application.

Table 3. Small Group Observation Results

Observation Indicator	Respondents					
	R1	R2	S1	S2	T1	T2
Implementation related to the process of using the Desmos application assisted by liveworksheet	✓	✓	✓	✓	✓	✓
Ease of use of Desmos application assisted by liveworksheet	✓	✓	✓	✓	✓	✓
Learning materials/activities in the Desmos application assisted by liveworksheet	✓	✓	✓	✓	✓	✓
Learner acceptance regarding interest and attraction to the appearance of the Desmos application assisted by liveworksheet	✓	✓	✓	✓	✓	✓

Noted: ✓ = feasible; X = there are constraints; R1= first low ability learner; R2= second low ability learner; S1= first moderate ability learner; S2= the second medium ability learner; T1= first high ability learner; T2= the second high ability learner

The last stage of the ADDIE model is the evaluation stage. At this stage, the researcher gave a questionnaire to students to find out the students responses after using the media on the Desmos application assisted by liveworksheet in the learning process. The results of the learner response questionnaire are presented in Table 4.

Table 4. Analysis of Learner Response Results

Statements	Answer options			
	SS	S	KS	TS
Desmos application media assisted by liveworksheet uses language that easy to understand	53.57%	46.43%	0%	0%
The media design of liveworksheet-asissted desmos application used has an attractive appearance	32.14%	67.86%	0%	0%
Instructions activities in Desmos application media assisted by liveworksheet is clear, making it easier to do all activities	46.43%	50.00%	3.57%	0%
The use of Desmos application media assisted by liveworksheet makes it easier to understand learning material	35.71%	50.00%	14.29%	0%
Desmos application media assisted by liveworksheet increases learning motivation	46.43%	39.29%	14.29%	0%
Shape, model and font size that used are easy to read	42.86%	46.43%	10.71%	0%
Desmos application media assisted by liveworksheet contains practice questions that van test knowledge about quadratic equations	39.29%	57.14%	3.57%	0%
I enjoy learning by using Desmos application media assisted by liveworksheet	46.43%	53.57%	0%	0%
Usage Desmos application media assisted by liveworksheet train to express opinions	35.71%	64.29%	0%	0%
Desmos application media assisted by liveworksheet makes me more active in learning	60.71%	35.71%	3.57%	0%
Desmos application media assisted by liveworksheet makes chemistry lessons more interesting to learn	42.86%	50.00%	7.14%	0%
The presentation style of Desmos application media assisted by liveworksheet is fun	50.00%	50.00%	0%	0%
The use of Desmos application media assisted by liveworksheet makes it more curious to learn	35.71%	64.29%	0%	0%
I understand all the material contained in the Desmos application media assisted by liveworksheet	39.29%	60.71%	0%	0%
Desmos application media assisted by liveworksheet make it easier to learn quadratic equation material	60.71%	39.29%	0%	0%
The clarity of the images on the Desmos application edia assisted by liveworksheet make the learning process easier	50.00%	46.43%	0%	3.57%
Desmos application media assisted by liveworksheet is easy to access	53.57%	42.86%	3.57%	0%
Activities contained in the Desmos application media assisted by liveworksheet improve science process skills	46.43%	53.57%	0%	0%
The content of the Desmos application media assisted by liveworksheet is very usedul for me	50.00%	46.43%	3.57%	0%
I was very excited when using the Desmos application media assisted by liveworksheet	39.29%	57.14%	3.57%	0%

Table 4 shows the percentage of students responses to the desmos application media assisted by liveworksheet obtained from the results of the students' response questionnaire after using the desmos application media assisted by liveworksheet which includes media display, image clarity, presentation style, ease of use and access, language and material content, and learning activities contained therein. 39.29% of students strongly agree and 57.14% agree that the use of desmos application media assisted by liveworksheet is very interesting to use in the mathematics learning process. The use of digital media in the learning process is important to make students more active and learning more interactive (Faaiqoh & Ratnaningrum, 2024), especially since the use of this liveworksheet can contain multiple choice questions, drag and drop features, matching, essays, videos and images (Palumpun et al., 2022).

One way to improve students' mathematical literacy is to innovate in the learning process by using digital technology media (Pradana et al., 2020; Ramadhan et al., 2023). Desmos is one of the digital media for training problem-solving, discovery and experiential learning skills to build new knowledge (Chechan et al., 2023). So it is hoped that the development of a PBL-integrated demos application design assisted by a liveworksheet based on mathematical literacy can be a solution in an effort to prepare for the minimum competency assessment (AKM). Minimum competency assessment, character survey and learning environment survey are used in national assessment of students as material for assessing the quality of learning and as an evaluation of the performance of educational units (Khairi & Desnita, 2023). Solving various problems in minimum competency assessment requires reading literacy and mathematical literacy skills. Mathematical literacy skills are important for students to have because in real life, all of a person's activities are related to mathematics (Putra et al., 2016). Learners who have mathematical literacy will be able to formulate, interpret and apply mathematical concepts to solve problems in everyday life (Yopa et al., 2022; Qolbiyah & Sari, 2024).

Conclusion

The development of PBL-Integrated desmos application design assisted by mathematical literacy-based liveworksheet in AKM preparation efforts provides output in the form of teaching media developed with the ADDIE development model with 4 stages namely analysis, design, development and evaluation. The results of the feasibility test of learning media on learning quadratic equation material are declared very valid and very practical to use in learning mathematics at SMAN 3 Bireuen based on the results of media and material expert validation by covering several aspects.

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Author Contributions
Writing-original draft of article manuscript, review of results, B. N.; methodology, discussion, conclusion, F. R.; analysis, correction, review, and editing, W. I. And B. N.

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Conflicts of Interest
The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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