ISSN 2303-0992
ISSN online 2621-3176
Matematika dan Pembelajaran
Volume 13, No. 2, December 2025, p. 445-469
Submitted: August 25, 2025; **Revised**: : December 9, 2025; **Accepted**: December 24, 2025

DEVELOPMENT OF JUWANA HERITAGE IN MATHEMATICS ANDROID APPLICATION INTEGRATED WITH PROBLEM-BASED LEARNING ASSISTED BY ADOBE ANIMATION TO IMPROVE MATHEMATICAL PROBLEM SOLVING SKILLS

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Abstrak

Pemecahan masalah matematis merupakan kemampuan yang dikembangkan untuk mencapai SDGs pada bidang pendidikan berkualitas. Namun hasil PISA 2022 menunjukkan kemampuan pemecahan masalah siswa di Indonesia tergolong rendah. Inovasi pembelajaran diperlukan untuk meningkatkan kemampuan pemecahan masalah melalui pengembangan aplikasi android terintegrasi Problem Based Learning (PBL) dengan nuansa budaya. Penelitian ini bertujuan mengembangkan aplikasi androind juwana heritage in mathematics terintegrasi PBL berbantuan adobe animate. Metode penelitian Research and Development (R&D) dengan model ADDIE (Analyze, Design, Develop, Implementation, dan Evaluation). Data bersumber dari angket validasi, angket kepraktisan angket respon siswa, dan tes kemampuan pemecahan masalah. Hasil uji kevalidan sebesar 89,35% kategori sangat valid. Hasil uji kepraktisan sebesar 87,7% kategori sangat praktis. Uji keefektivan aplikasi melalui uji t, uji z, dan uji proporsi. Hasil uji statistika menunjukkan bahwa (1) rata-rata kemampuan pemecahan masalah matematis siswa dengan aplikasi *juwana heritage in mathematics* terintegrasi PBL mencapai ketuntasan minimum sebesar 80, (2) proporsi kemampuan pemecahan masalah siswa dengan aplikasi *juwana heritage in mathematics* terintegrasi PBL yang telah mencapai ketuntasan lebih dari 75%, (3) rata-rata kemampuan pemecahan masalah matematis siswa dengan aplikasi *juwana heritage in mathematics* terintegrasi PBL lebih tinggi dibandingkan siswa dengan PBL (4) proporsi ketuntasan siswa dengan aplikasi *juwana heritage in mathematics* terintegrasi PBL lebih tinggi dibandingkan siswa dengan PBL dan (5) peningkatan kemampuan pemecahan masalah pada siswa dengan aplikasi juwana heritage in mathematics terintegrasi PBL lebih tinggi dibandingkan siswa dengan PBL.

Kata kunci: Aplikasi Android; *Juwana Heritage in Mathematics*; Pemecahan Masalah Matematis; *Problem Based Learning*

Abstract

Mathematical problem-solving skills need to be developed to achieve the SDGs, specifically in quality education. However, the results of the 2022 PISA (Philosophy of Mathematics) show that the problem-solving ability of students in Indonesia is relatively low. Innovation is needed to improve problem-solving abilities by developing an Android application integrated with Problem-Based Learning (PBL) with cultural nuances. The study aims to

develop an Android application, "Juwana Heritage in Mathematics," integrated with PBL assisted by Adobe Animate. Research and Development (R&D) with the ADDIE model (Analyze, Design, Develop, Implementation, and Evaluation) is the research method. Data sourced from validation questionnaires, practicality questionnaires, student response questionnaires, and problem-solving ability tests. The validity test results were 89.35% in the very valid category. The practicality test results were 87.7% in the very practical category. Test the effectiveness of the application through t-tests, z-tests, and proportion tests. The results of statistical tests show that (1) the average mathematical problem solving ability of students with the Juwana Heritage in Mathematics application integrated with PBL reached a minimum completion of 80, (2) the proportion of students' problem solving ability with the Juwana Heritage in Mathematics application integrated with PBL that had reached completion was more than 75%, (3) the average mathematical problem solving ability of students with the Juwana Heritage in Mathematics application integrated with PBL was higher than students with PBL (4) the proportion of students' completion with the Juwana Heritage in Mathematics application integrated with PBL was higher than students with PBL and (5) the increase in problem solving ability in students with the Juwana Heritage in Mathematics application integrated with PBL was higher than students with PBL.

Keywords: Android Application, Juwana Heritage in Mathematics, mathematical problem solving, Problem Based Learning

Citation: Munahefi, D.N., Al-qonita, A.S. 2025. Development of Juwana Heritage in Mathematics Android Application Integrated with Problem-Based Learning Assisted by Adobe Animation to Improve Mathematical Problem Solving Skills. *Matematika dan Pembelajaran*, 13(2), 445-469. DOI: http://dx.doi.org/10.33477/mp.v13i2.11696

INTRODUCTION

Problem-solving skills are crucial to develop through the learning process at school. The learning process at school links problem-solving skills with mathematics. Students must possess mathematical problem-solving skills, valuable competencies that can potentially develop students' reasoning (Amalina & Vidákovich, 2023; Jäder et al., 2020). Problem-solving skills are also a fundamental goal and one of the main standard competencies of the mathematical thinking process (Ukobizaba et al., 2021). Students' success in learning mathematics can also be measured through their mastery of problem-solving skills (Rocha & Babo, 2024).

Mathematical problem solving is one of the core skills that must be achieved at each phase of learning outcomes in the Independent Curriculum. According to Polya (2004) problem-solving skills, which consist of four stages: understanding the problem, planning a strategy, implementing the plan, and reviewing the results, play a fundamental role in mathematics learning because they place the thinking process at the core of learning activities. The application of Polya's steps in mathematics learning guides students in dealing with non-routine problems and connecting concepts to real-world situations. However, mathematics learning practices tend to emphasize providing formulas and routine practice problems without guiding students through the problem-solving stages (Santos-trigo, 2024; Torres-peña et al., 2025). This condition results in low mathematical problem-solving skills, because students are not trained to analyze non-routine situations, choose appropriate strategies, or evaluate solutions obtained.

Indonesian students' problem-solving abilities are relatively low. Several studies conducted by Syarifah et al., (2021), Suparman et al., (2021), Utomo & Syarifah (2021), Zulnaidi et al., (2021), Daryanes et al., (2023), and Ulya et al., (2024) indicate that Indonesian students' problem-solving abilities are relatively low. A preliminary study at SMP Negeri 1 Juwana showed that the average student's mathematical problem-solving skills only reached a total average of 26.74 out of a maximum score of 100. An interview with a mathematics teacher at SMP Negeri Juwana stated that the ineffectiveness of the learning process due to low student learning motivation is one of the factors behind the low problem-solving abilities.

Simanjuntak et al., (2021) stated that the ineffectiveness of the learning process is one of the factors in students' low problem-solving abilities. This ineffective learning process can be caused by a lack of student interest in the learning process due to the less-than-optimal use of learning media (Kwangmuang et al., 2021). Conventional learning methods and the use of technology-based learning media were still not optimal, which is a factor in students' low mathematical problem-solving abilities (Araiza-Alba et al., 2021; Wei et al., 2020;

Yasin et al., 2020; Zulnaidi et al., 2020). Therefore, it is necessary to develop technology-based learning media related to problems in the students' environment in mathematics learning so that it motivates students' learning, which positively impacts mathematical problem-solving abilities.

Android is a technology application that can be utilized as an innovative, interactive, effective and efficient learning media. Android application-based learning media could be developed in the mathematics learning process to improve mathematical problem-solving skills (Gebze et al., 2020; Nurwita et al., 2023). Android has an open source nature, which provides the freedom to create Android applications through software. Adobe Animate is the software that can be used to develop the latest and easy-to-use Android application-based learning media (Firdaus et al., 2023).

The developed Android application should also be supported by learning content that can improve mathematical problem-solving skills. The Problem-Based Learning (PBL) model could help improve students' mathematical problem-solving skills (Permatasari et al., 2020; Suparman et al., 2021; Surur et al., 2020). PBL could also encourage students to solve problems independently through empirical data exploration with real-life problems as stimuli (Asmar & Delyana, 2022). Therefore, this study aims to develop interactive Android learning media supported by Adobe Animate with PBL for problem-solving skills.

PBL plays a role in developing problem-solving skills. PBL is a student-centered learning process that involves solving real-world problems. PBL also plays a role in increasing student learning motivation and fostering student initiative in solving problems (Wijnia et al., 2024). PBL improves problem-solving skills through several steps, namely (1) orienting students to the problem; (2) organizing students to learn; (3) guiding individual and group problem-solving; (4) developing and presenting work results; (5) analyzing and evaluating the mathematical problem-solving process (Hendriana et al., 2018).

Cultural integration in mathematics learning through the use of Android applications can facilitate students in solving problems related to everyday life. Interactive Android learning media enable students to learn independently and provide flexibility for them (Akbar et al., 2022). The mathematics learning process is also more enjoyable and contextual through the application of ethnomathematics. Putri et al. (2023) found that developing interactive media with cultural nuances, equipped with the Problem-Based Learning model, effectively improves students' mathematical problem-solving abilities. The use of Android in mathematics learning, incorporating cultural nuances, increases student participation and interest in problem-solving (Isrokatun, 2025).

Implementing PBL in Android applications needs to be supported by cultural values that grow in the community to achieve optimal mathematical problem-solving abilities. SMP Negeri 1 Juwana, located in Juwana District, Pati Regency, has a unique culture, such as the tradition of traveling around the punden, Bukak Selambu, Sedekah Bumi, to Sedekah Laut. Juwana is also famous for one of its typical products, namely Bandeng Presto, typical crafts in the form of hand-drawn batik, typical colonial heritage buildings that are still functioning today, and rules in each village that are still believed by the community, such as the prohibition on making houses from red bricks and selling rice. However, the uniqueness of this typical Juwana Culture is still less highlighted, and almost no research links the Juwana Culture with mathematics. Therefore, this research aims to develop the Juwana Heritage in Mathematic android application based on Problem-Based Learning assisted by Adobe Animate to improve students' mathematical problem-solving skills. Based on these problems, this study aims to answer the research question: Is the Juwana Heritage in Mathematics android application, based on Problem-Based Learning and assisted by Adobe Animate, valid, practical, and effective for enhancing mathematical problem-solving abilities?

METHOD

The research uses the Research and Development method with the ADDIE model. The stages of this research are based on the ADDIE model, including analysis, design, development, implementation, and evaluation (Branch, 2009) The analysis stage involves observation and interviews with teachers and students of SMPN 1 Juwana as a form of problem analysis, analysis of learning objectives, and analysis of student needs for effective learning media to improve mathematical problem-solving skills. The design stage involves designing an Android application media that will be developed using Canva. In the development stage, researchers use Adobe Animate software to produce the Juwana Heritage in Mathematics Android application. Next, the application will be assessed, and its validity and practicality will be measured. The implementation stage involves testing the Juwana Heritage in Mathematics application in mathematics learning activities. The evaluation stage measures the effectiveness of the Juwana Heritage in Mathematics application on students' mathematical problem-solving skills. Figure 1 shows the research stages used.

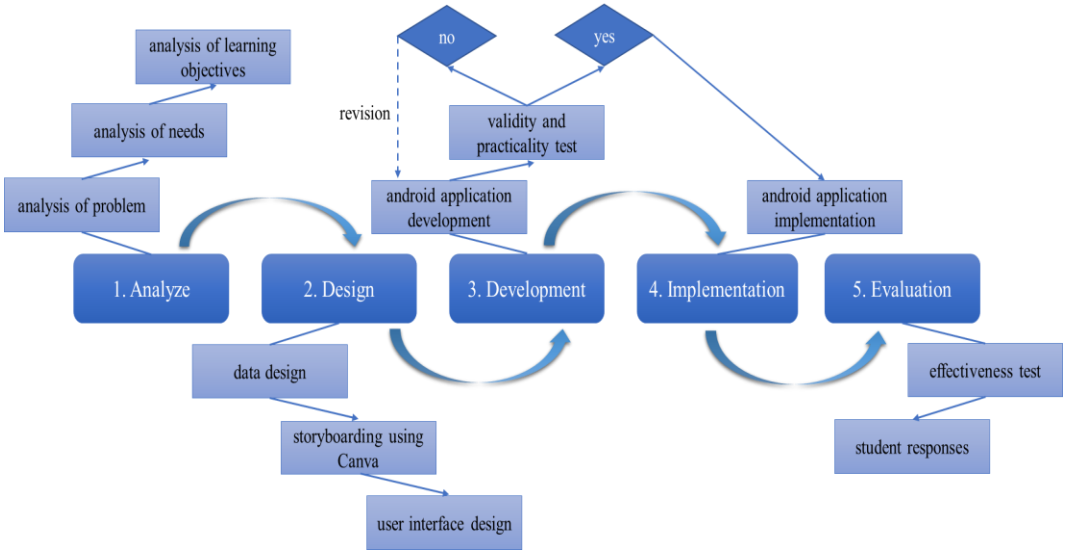


Figure 1. Research Stage Scheme

The study population was eighth-grade students of SMP Negeri 1 Juwana. The sampling technique used in this study was cluster random sampling. The

eighth-grade student population consisted of 11 classes, from which two classes were randomly sampled. The samples selected were class VIII G, with 32 students as the experimental class, and class VIII F, with 28 students as the control class. The experimental class used the Juwana Heritage in Mathematics Android application integrated with PBL, while the control class used PBL. A pre-post control group design was employed in a quantitative research study to evaluate the effectiveness of the Juwana Heritage in Mathematics Android application on mathematical problem-solving skills. The research was conducted from November 26 to December 10, 2024, during which the researcher directly taught in both the experimental and control classes. The quantitative research design is shown in Table 1.

Table 1. Pre-post Control Group Design

Class	Pre-test	Treatment	Post-Test
Experimental class	Mathematical problem-solving skills test	The Juwana Heritage in Mathematics Android application integrated with PBL	Mathematical problem-solving skills test
Control class	Mathematical problem-solving skills test	PBL	Mathematical problem-solving skills test

Data collection techniques in the form of tests and questionnaires. Tests to measure students' mathematical problem-solving skills with cronbach's alpha 0,74. The questionnaires are in the form of validity questionnaires and practicality questionnaires. The validity aspects used include content, presentation, language, and learning innovation aspects. Three experts and two practitioners validated the validity of the questionnaire. The practicality aspects used include effective, interactive, efficient, and creative. As many as 10 students from SMP Negeri 1 Juwana will validate the practicality of the application questionnaire.

The development of the Juwana Heritage in Mathematics Android application integrated with PBL went through several tests: the validity, practicality, and effectiveness. A validity analysis was conducted to determine whether the developed media met the valid criteria based on expert assessment. Practicality

analysis was conducted to determine the ease of use of the Android application. The analysis to test validity and practicality used the formula: $P(s) = \frac{S}{N} \times 100\%$ with information S: total score obtained and N: maximum score (Arifin, 2009). Table 2 shows the criteria for the level of validity and practicality. The Juwana Heritage in Mathematics application, integrated with PBL, on students' mathematical problem-solving skills was considered valid if the score was above 80%. An effectiveness analysis was conducted to analyze the effectiveness of the Android application on mathematical problem-solving skills. The effectiveness tests used included the t-test, z-test, and N-gain. Statistical tests begin with prerequisite tests through normality tests and homogeneity tests. The t-test criteria are that the hypothesis is accepted if $t_{\text{count}} < t_{table}$ dengan $t_{table} = t_{(1-a)}$ obtained from the distribution list t with $dk = n - 1$. The z-test criteria are that the hypothesis is accepted if $z_{\text{count}} < z_{table}$ with $z_{table} = z_{(0,5-a)}$ obtained from the distribution list z. N-Gain test to determine the average increase in students' mathematical problem-solving abilities.

Table 2. Criteria for Validity and Practicality Levels

Score	Validity Criteria	Practicality Criteria
$0\% < P \leq 20\%$	Invalid	Not Practical
$20\% < P \leq 40\%$	Less Valid	Less Practical
$40\% < P \leq 60\%$	Quite Valid	Quite Practical
$60\% < P \leq 80\%$	Valid	Practical
$80\% < P \leq 100\%$	Very Valid	Very Practical

RESULT AND DISCUSSION

The developed application discusses the topic of Linear Equations of One Variable by including indicators of mathematical problem-solving skills and elements of Juwana Culture so that it can train students to solve mathematical problems through their surrounding environment, namely, Juwana Culture. The developed application follows the stages in the ADDIE model with the following results.

The analysis aims to identify problems in the eighth-grade mathematics learning process at SMP Negeri 1 Juwana. Interviews revealed that the curriculum implemented in eighth grade at SMP Negeri 1 Juwana is an independent curriculum that emphasizes differentiated learning. However, the learning process is not supported by media that can develop students' mathematical problem-solving skills. Limited resources and time prevent teachers from developing innovative learning media that support mathematical problem-solving skills.

Interviews with eighth-grade students of SMP Negeri 1 Juwana were conducted to analyze the achievement of students' mathematical problem-solving skills. Factors causing students to experience difficulties in solving mathematical problems are that students are not interested in abstract mathematics learning, so that mathematical concepts are poorly understood. Students are more interested when mathematics is brought to activities in their environment. Therefore, mathematics learning needs to be linked to local culture. Students need interactive, technology-based learning media that motivate students to learn to maximize the improvement of their mathematical problem-solving skills. Analysis of system needs in developing learning media in the form of applications using the help of Adobe Animate software, converted into Android.

The results of discussions with mathematics teachers at SMP Negeri 1 Juwana stated that students had difficulty solving mathematical problems on the topic of linear equations and inequalities in one variable. The material can be linked to the culture in the Juwana area and integrated with technology through an Android application. Implementing PBL in the application content supports the development of mathematical problem-solving skills. The solution was implemented to improve mathematical problem-solving skills by developing the Juwana Heritage in Mathematics Android application integrated with PBL, assisted by Adobe Animate.

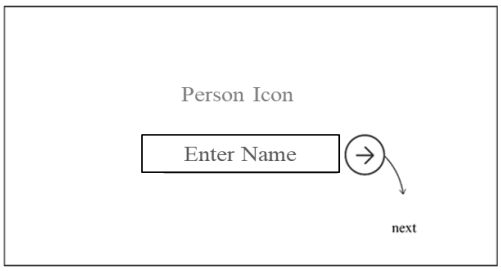
Design Stage

The design phase of this research includes data design, storyboard creation, navigation button design, and user interface design. Data design determines the

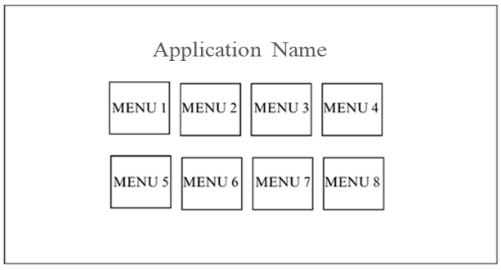
application's presentation design. Storyboard design visually depicts the storyline so the application's flow can be structured. Navigation design aims to define commands in the application being developed, while user interface design functions to design the application's appearance.

Data design is the preparation of the application menu design based on the results of the previous stage analysis. The menu design in this application consists of materials, practice questions in the form of games, discussion forums, and quizzes integrated with Budaya Juwana. Each menu of learning material is presented in two ways: through video or text. In the discussion forum, students are given several practice questions that will be discussed during the learning process in groups. Practice questions present problem-solving questions provided in the form of games and quizzes. Practice questions in games are created using the Gimkit application. In contrast, practice questions in the form of quizzes are given a time limit for completion, correct or incorrect corrections, and the calculation of final points achieved.

(a) Initial View of the Application



(b) Application Identity



(c) Application Main Menu

Figure 2. Storyboard

The storyboard in the application as shown Figure 2 consists of: the initial application display, application identity, and the main application menu. The application is designed with an initial display of an illustration of the Juwana Culture, equipped with a play button to enter the main menu section. The application identity functions to input the student's name so that each individual can identify the use of the application. The main application menu consists of 8: Learning Achievements and Learning Objectives, apperception, discussion, developer profile, evaluation, J-Explore, and bibliography.

The navigation design aims to determine the commands in the developed application. Initially, the application will display the Juwana Heritage in Mathematics Application logo and the Semarang State University logo, which will automatically continue to the initial display, an illustration of Juwana City, equipped with play, sound, exit, and info navigation buttons. The play navigation button will take the user to the personal data entry menu equipped with a next button. The following navigation button will take the user to the eight main menu.

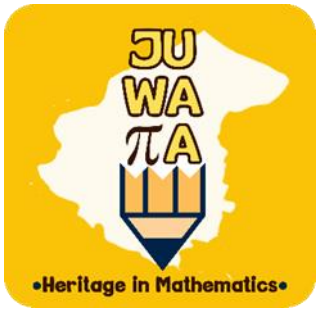


Figure 3. Application Logo

Figure 4. Cultural Integration on the Application's Initial Display

User interface design is used to design the appearance of the application. The design includes designing the logo as shown Figure 3 and application display as shown Figure 4 using the Canva application. The application display design is also carried out at this stage, including the initial application display design, Virtual Reality (VR) artstep, and application background design that integrates elements of Juwana Culture, such as hand-drawn batik, a batik museum, the Milkfish Monument, kecap gentong, Juwana town square, Punden Bakaran, and so on.

Development Stage

The development phase included application creation and formative evaluation, including validity and practicality tests by experts and students. In this phase, researchers utilized designs created in the Canva app, including background designs and navigation buttons, to develop them into an app using Adobe Animate software. The app was created in Adobe Animate in FL format, then converted to AIR for Android, and then uploaded as an APK.

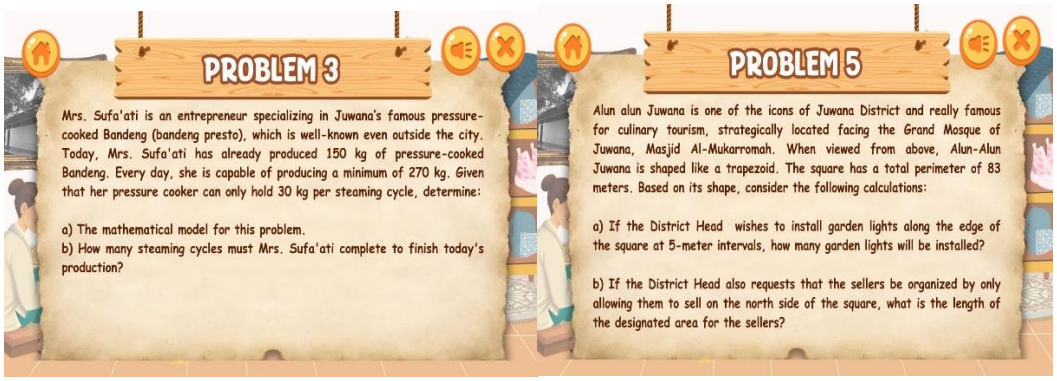
The content feasibility aspect of the Juwana Heritage in Mathematics Application includes four sub-aspect indicators observed, namely the suitability of the material with learning outcomes (CP) and learning objectives (TP), material accuracy, supporting learning materials, and material up-to-dateness. The presentation feasibility aspect includes four indicators: presentation techniques, presentation supports, learning presentation, and completeness of presentation. The language aspect includes six indicators: straightforward, commutative, dialogic, and interactive, suitability to the level of student development, coherence and integration of thought flow, and using terms, symbols, and icons. The learning innovation aspect includes three indicators: Novelty, Integration, and Student Achievement.

Table 3. Validity Test Results by Validator

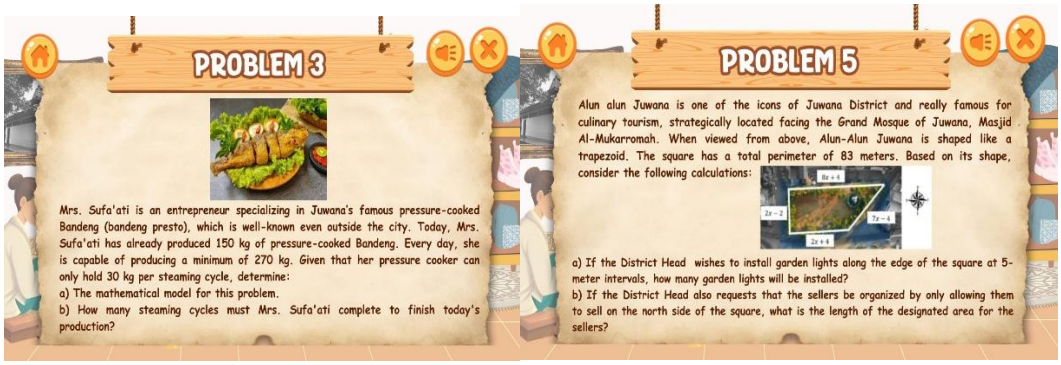
No	Aspects observed	Validator 1	Validator 2	Validator 3	Validator 4
1	Content Suitability Aspect	80,6%	93,18%	89,7%	93,1%
2	Presentation Suitability Aspect	85%	93,3%	95%	96,6%
3	Language Aspect	76,7%	96,4%	87,5%	96,4%

4 Learning Innovation Indicators	79,1%	100%	79,1%	91,6%
Average	80,4%	95,7%	87,8%	94,4%

The Juwana Heritage in Mathematics application was validated by two validators from media experts and two validators from practitioners. Validator 1, a professor in mathematics, stated that the Juwana Heritage in Mathematics application received a percentage score of 80.4%. Validator 2, a doctoral student in Mathematics Education, stated that the Juwana Heritage in Mathematics application received a percentage score of 95.7%. Validator 3, a mathematics teacher in Pati Regency, stated that the Juwana Heritage in Mathematics application received a percentage score of 87.8%. Validator 4, an SMP Negeri 1 Juwana mathematics teacher, stated that the Juwana Heritage in Mathematics application received a percentage score of 94.48%. Table 3 shows the validation results from each validator.



(a) Before Revision



(b) After Revision

Figure 5: Addition of Cultural Images or Illustrations to Each Problem

Some validator comments on the Juwana Heritage in Mathematics application include adding images to the problems so that cultural introduction is not just descriptive, and the menus are numbered according to the sequence of activities. Figure 5 shows images and illustrations added to the problems, allowing students to understand the culture better and facilitating understanding of the problems presented. Figure 6 shows the addition of numbers to each corner of the menu on the main menu, allowing students to open the application sequentially and in a structured manner when learning independently.

(a) Before Revision (b) After Revision

Figure 6. Adding Sequence to the Main Menu

The practicality test of this application was obtained by collecting assessment data from ninth-grade students of SMP Negeri 1 Juwana who had received the material on Linear Equations and Inequalities with One Variable. The researcher used four indicators in the practicality test: effective, interactive, efficient, and creative. Table 4 shows the results of the application's practicality test for each indicator. The practicality test for the Juwana Heritage in Mathematics application resulted in a percentage value of 87.7%, including the "Very Practical" category.

Table 4. Description of Practicality Test Results

Observed Indicators	Percentage Value	Criteria
Effective	91,2%	Very Practical
Interactive	85,8%	Very Practical
Efficient	86,6%	Very Practical
Creative	88,7%	Very Practical

Average	87,7%	Very Practical

Implementation Stage

The implementation stage is applying learning media in the form of the Juwana Heritage in Mathematics Application in the Problem-Based Learning Model. Students are asked to bring a mobile phone to access the Juwana Heritage in Mathematics Application with the permission of the homeroom teacher. Students are also directed to access the application according to the number sequence in the application. The Juwana Heritage in Mathematics Application uses a problem-based learning model by orienting several problems related to the Linear Equations and Inequalities of One Variable material in the "discussion" menu in the Juwana Heritage in Mathematics Application. Students are divided into 5-6 groups, and each group is invited to access the application through the barcode provided.

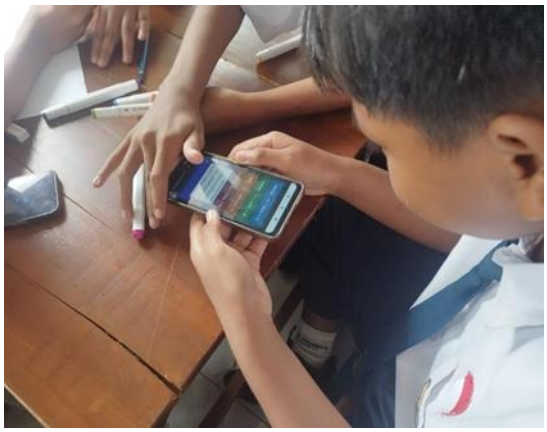


Figure 7. Students using the Juwana Heritage Application in Mathematics

Researchers identified several problems related to the material on linear equations and Inequalities with One Variable in the "Discussion" menu of the Juwana Heritage in Mathematics application. Students carried out the learning process in groups by accessing the application through the provided barcode. Students actively participated in the discussion process, attempting to solve problems using reference sources provided in the application and textbooks. The

learning process also facilitated each group's sharing of the results of their discussions.

Evaluation Stage

The evaluation phase includes three activities: initial evaluation, final evaluation, and student responses. The initial evaluation includes a prerequisite test of students' mathematical problem-solving skills. The final evaluation aims to test the hypothesis. Student responses assess students' responses to the Juwana Heritage in Mathematics application implemented in the learning process.

The initial evaluation consisted of normality and homogeneity tests for students' mathematical problem-solving skills. The normality test results for the control and experimental classes yielded a sign value of 0.200 > 0.05 and a sign value of 0.166 > 0.05, respectively, thus rejecting H_0. Therefore, the mathematical problem-solving skills of students in the control and experimental classes originate from normally distributed populations. The homogeneity test yielded a sign value of 0.274 > 0.05, indicating that the mathematical problem-solving skills of both the control and experimental classes originate from homogeneous populations.

The final evaluation aimed to test the hypotheses, including a learning mastery test, a mean difference test, and a test of improvement in students' mathematical problem-solving skills. The results of the individual mastery test obtained a value of $t_{count} = 2.169 > t_{table} = 1.696$, then H_0 is rejected, so that the average mathematical problem-solving skills of students who use the Juwana Heritage in Mathematics Application on the Problem-Based Learning Model is more than 80. The Classical mastery test obtained $Z_{count} = 2.04 > Z_{table} = 1.64$, then H_0 is rejected, so that the percentage of students who use the Juwana Heritage in Mathematics Application on Problem Based Learning reaches a score of 80, more than 75%. The results of the comparative test value of $t_{count} = 7.29 > t_{table} = 1.67$ then H_0 is rejected so that the average mathematical problem solving ability of students in the class that uses the Juwana Heritage in Mathematics Application on Problem Based Learning is more than the average mathematical problem solving

skills of students in the class that uses the Problem Based Learning model. The results of the proportion test show $Z_{hitung} = 4.68 > Z_{tabel} = 1.64$ then H_0 is rejected so that the proportion of students' mathematical problem solving skills that have achieved a score of 80 in the class using the Juwana Heritage in Mathematics Application is more than the proportion of students' mathematical problem solving skills that use the Problem Based Learning model. The Comparative Test of Improvement in Problem Solving Skills begins with the N-gain test, followed by Welch's t-test because the data is not homogeneous. The results of the N-Gain test are attached in attachment 1. The average N-Gain value of the experimental class was 0.77, which is included in the high category, while the average N-Gain value of the control class was 0.54, which is included in the medium category. The results of the Welch's t-test show $t' = 4{,}0033 > \frac{w_1 t_1 + w_2 t_2}{w_1 + w_2} = 1{,}701$, then H_0 is rejected, so that the average increase in students' mathematical problem-solving skills in the class using the Juwana Heritage in Mathematics Application is more than the proportion of students' mathematical problem-solving skills that use the Problem-Based Learning model.

Table 5. Descriptive Statistics

Group	n	Mean (Pre-test)	SD (Pre-test)	Mean (Post-test)	SD (Post-test)	N-Gain
Experiment	32	41,8	17,8	87,1	9,7	0,77
Control	28	39,4	14,8	73,6	13,5	0,54

Table 6. Student Response Test Results

Percentage score	Category	Total
81%-100%	Very Good	27
61%-80%	Good	5
41%-60%	Fairly Good	0
21%-40%	Poor	0
0-20%	Very Poor	0

The student response test aims to analyze student responses to the application. The number of students who participated in this test was 32, who used the Juwana Heritage in Mathematics Application. Based on Table 6, student responses to the

Juwana Heritage in Mathematics application in PBL on students' mathematical problem-solving skills obtained an average response of 88.2% which is included in the very good category, so that the application does not need to be revised and can proceed to the implementation stage.

The Juwana Heritage in Mathematics application in Problem-Based Learning, assisted by Adobe Animate, contains material on Linear Equations and Inequalities in One Variable that is completely arranged and adjusted to learning outcomes (CP) and learning objectives (TP). The material is implemented with the Problem-Based Learning model by providing contextual problems and presenting real examples of the material being studied. Therefore, students who learn with the application are actively involved in solving problems according to their reasoning to improve their mathematical problem-solving skills. Hendriana et al., (2018) and Azimah et al., (2020) stated that Problem-Based Learning positively influences students' mathematical problem-solving skills.

The Juwana Heritage in Mathematics application presents material coherently and systematically, from the introduction, content, and conclusion, which are tailored to learning outcomes and objectives, and are packaged attractively through menus, navigation buttons, and the application display. The developed application also has a user manual and a clear summary. The application's presentation of material, problems, and assessments is also adapted to existing cultural phenomena and invites students to be actively involved in the learning process. Students can easily access various features, buttons, and visual models in the form of cultural illustrations integrated into the problems and Virtual Reality Exhibitions according to learning needs. The presentation of various interesting features in audio and visuals in the Juwana Heritage in Mathematics application can increase student participation and interest in solving a problem. Sukmawati et al., (2022), Harianto & Sudatha, (2023), Amir et al., (2018), Setiawati et al., (2024) also stated that mathematical problem-solving skills can increase in line with increased student participation and interest through engaging and interactive learning. Android

applications can be one of them through learning media that can interestingly present visually and audibly material.

The Juwana Heritage in Mathematics application, integrated with Problem-Based Learning, can guide students in understanding problems more deeply, direct them in designing learning strategies, and evaluate successful solutions. Students using The Juwana Heritage in Mathematics application, integrated with Problem-Based Learning, can conduct independent exploration through contextual practice questions, thereby training students to identify problems, devise problem-solving strategies, and evaluate results. These three things are the main components in mathematical problem-solving (Sinaga et al., 2023). Tursynkulova et al., (2023)also stated that PBL emphasizes a comprehensive thinking process, which effectively improves key aspects of mathematical problem-solving skills.

The application also presents various cultural illustrations in the form of animations and real photos so that students can not only imagine the culture being studied but also learn about the culture directly with more interesting media. Nasution & Lailia, (2023) stated that interactive learning media equipped with many animations can make learning media more interesting and impact student enthusiasm so that it can improve mathematical problem-solving skills. The cultural nuances contained in the presentation of learning materials in the application make students motivated in solving a problem because it is closely related to daily activities (Nur et al., 2020; Nursyahidah et al., 2018; Safitri et al., 2023; Yuniari et al., 2025). The Juwana Heritage in Mathematics application is equipped with interactive quizzes that help students understand the material, thus motivating them to be more confident in working on various mathematical problems, which impacts their mathematical problem-solving skills. The role of interactive quizzes in improving mathematical problem-solving skills is also aligned (Setiyani et al., 2020). The interactive quizzes in the Juwana Heritage in Mathematics application, equipped with evaluations and providing opportunities for students to repeat and correct answers on the quiz, also improve students' mathematical problem-solving

skills. Haryani & Ayuningtyas, (2021) explain that interactive learning can increase student problem-solving engagement.

CONCLUSION

The development and research of the Juwana Heritage in Mathematics application for Problem-Based Learning (PBL) using Adobe Animate has been proven valid and practical for use in mathematics learning. The Juwana Heritage in Mathematics application for Problem-Based Learning (PBL) is effective in enhancing the mathematical problem-solving skills of students at SMP Negeri 1 Juwana, as it successfully integrates problem-based learning with interactive media that incorporates local cultural nuances. The Juwana Heritage in Mathematics application, integrated with Problem-Based Learning, features various interesting elements, including the presentation of material with cultural nuances and interactive quizzes to enhance mathematical problem-solving skills.

Using the Juwana Heritage in Mathematics application can be an alternative for teachers to improve students' mathematical problem-solving skills, but researchers hope to develop the application's features further. Hopefully, the Juwana Heritage in Mathematics application will be equipped with essay-based practice questions. The material presented in the Juwana Heritage in Mathematics application is also more diverse, not limited to linear equations and inequalities in one variable. One engaging feature that students can use to learn about the Juwana culture in the app is the Virtual Reality Exhibition feature. The Virtual Reality Exhibition feature can be developed to showcase various Indonesian cultures, integrated into mathematics lessons, and used to introduce them to students in a fun and engaging way.

REFERENCES

Akbar, F. H., Rahayu, R., & Wanabuliandari, S. (2022). The Effectiveness of PBL Model with STEAM Approach Assisted by Android Application on Students ' Mathematical Problem Solving Ability. 6(3), 548–559. https://doi.org/10.23887/jet.v6i3.45693

Amalina, I. K., & Vidákovich, T. (2023). Development and differences in mathematical problem-solving skills: A cross-sectional study of differences in demographic backgrounds. Heliyon, 9(5). https://doi.org/10.1016/j.heliyon.2023.e16366

Amir, M. F., Hasanah, F. N., & Musthofa, H. (2018). Interactive multimedia based mathematics problem solving to develop students' reasoning. Int. J. Eng. Technol, 7(2.14), 272–276.

Araiza-Alba, P., Keane, T., Chen, W. S., & Kaufman, J. (2021). Immersive virtual reality as a tool to learn problem-solving skills. Computers \& Education, 164, 104121. https://doi.org/10.1016/j.compedu.2020.104121

Arifin, Z. (2009). Evaluasi pembelajaran. Bandung: Remaja Rosdakarya.

Asmar, A., & Delyana, H. (2022). The Influence of Independence and Motivation to Learn Through Pbl on Students'problem-Solving Abilities. Aksioma: Jurnal Program Studi Pendidikan Matematika, 11(3), 1690–1700. https://doi.org/10.24127/ajpm.v11i3.5884

Azimah, W., Hendrayana, A., & Fatah, A. (2020). The Effect of Modified Cognitive Load Theory Problem Based Learning Models to Problem Solving Abilities. Matematika Dan Pembelajaran, 8(2), 112–121. https://doi.org/10.33477/mp.v8i2.1366

Branch, R. M. (2009). Approach, Instructional Design: The ADDIE. In Department of Educational Psychology and Instructional Technology University of Georgia (Vol. 53, Issue 9). https://doi.org/10.1007/978-0-387-09506-6

Daryanes, F., Darmadi, D., Fikri, K., Sayuti, I., Rusandi, M. A., & Situmorang, D. D. B. (2023). The Development of Articulate Storyline Interactive Learning Media Based on Case Methods to Train Student's Problem-Solving Ability. Heliyon, 9(4). https://doi.org/10.1016/j.heliyon.2023.e15082

Firdaus, D. F., Suripah, S., & Angraini, L. M. (2023). Development of Animated Video-Based Mathematics Learning Media Using Adobe After Effect on The Three-dimensional Material to Improve Mathematical Literacy. Kreano, Jurnal Matematika Kreatif-Inovatif, 14(2), 267–279. https://doi.org/10.15294/kreano.v14i2.39628

Gebze, D. A., Perwati, S., & others. (2020). Improving problem-solving ability in physics through android-based mobile learning application. Journal of Physics: Conference Series, 1440(1), 12022. https://doi.org/10.1088/1742-6596/1440/1/012022

Harianto, N. A., & Sudatha, I. G. W. (2023). Interactive multimedia with problem-based learning in mathematics. Journal of Education Technology, 7(4), 610–618.

https://doi.org/10.23887/jet.v7i4.64656

Haryani, F., & Ayuningtyas, N. (2021). The impact of interactive online learning by Pear Deck during COVID-19 pandemic era The impact of interactive online learning by Pear Deck during COVID-19 pandemic era. Journal of Physics: Conference Series. https://doi.org/10.1088/1742-6596/1957/1/012006

Hendriana, H., Johanto, T., & Sumarmo, U. (2018). The Role of Problem-Based Learning to Improve Students' Mathematical Problem-Solving Ability and Self Confidence. Journal on Mathematics Education, 9(2), 291–300.

Isrokatun, I. (2025). Enhancing Elementary Students ' Mathematical Problem-Solving Skills through a Culture-Based Android Application. 15(10), 2276–2288. https://doi.org/10.18178/ijiet.2025.15.10.2423

Jäder, J., Lithner, J., & Sidenvall, J. (2020). Mathematical problem solving in textbooks from twelve countries. International Journal of Mathematical Education in Science and Technology, 51(7), 1120–1136. https://doi.org/10.1080/0020739X.2019.1656826

Kwangmuang, P., Jarutkamolpong, S., Sangboonraung, W., & Daungtod, S. (2021). The development of learning innovation to enhance higher order thinking skills for students in Thailand junior high schools. Heliyon, 7(6). https://doi.org/10.1016/j.heliyon.2021.e07309

Nasution, M., & Lailia, H. (2023). " Animated Video Media": Improved Conceptual Understanding and Solving Mathematical Problems. AKSIOMA: Jurnal Program Studi Pendidikan Matematika, 12(1), 1344–1358. https://doi.org/10.24127/ajpm.v12i1.6892

Nur, A. S., Waluya, S. B., Rochmad, R., & Wardono, W. (2020). Contextual Learning with Ethnomathematics in Enhancing the Problem Solving Based on Thinking Levels. Journal of Research and Advances in Mathematics Education, 5(3), 331–344. https://doi.org/10.23917/jramathedu.v5i3.11679

Nursyahidah, F., Saputro, B. A., & Rubowo, M. R. (2018). Students Problem Solving Ability Based on Realistic Mathematics with Ethnomathematics. Journal of Research and Advances in Mathematics Education, 3(1), 13–24.

Nurwita, F., Kusumah, Y. S., & Juandi, D. (2023). Developing learning media based on Android application for improving math problem solving skill of junior high school students on Pythagorean Theorem. AIP Conference Proceedings, 2734(1), 90059. https://doi.org/10.1063/5.0163595

Permatasari, C. P., Yerizon, Y., Arnawa, I. M., & Musdi, E. (2020). Improving students' problem-solving ability through learning tools based on problem based learning. Journal of Physics: Conference Series, 1554(1), 12017. https://doi.org/10.1088/1742-6596/1554/1/012017

Polya, G. (2004). How to solve it: a new aspect of mathematical method second edition. In Princeton University Press: United States of America (Vol. 2, p. 253). https://doi.org/10.1515/9781400828678

Rocha, H., & Babo, A. (2024). Problem-solving and mathematical competence: A look to the relation during the study of Linear Programming. Thinking Skills and Creativity, 51, 101461. https://doi.org/10.1016/j.tsc.2023.101461

Safitri, M., Murtafiah, W., Sanusi, Lukitasari, M., & Lestari, N. D. S. (2023). Development of E-comic learning media based on ethnomathematics to improve problem solving in sequences and series materials. AIP Conference Proceedings, 2886(1), 20053. https://doi.org/10.1063/5.0154627

Santos-trigo, M. (2024). Problem solving in mathematics education : tracing its foundations and current research-practice trends. 211–222. https://doi.org/10.1007/s11858-024-01578-8

Setiawati, L. M., Mashup, Abdillah, & Syaharuddin. (2024). The Impact of Using Audio-Visual Interactive Media in Learning Mathematics. Indonesian Journal of Educational Research and Review, 7(2), 308–320. https://doi.org/10.23887/ijerr.v7i2.63824

Setiyani, S., Fitriyani, N., & Sagita, L. (2020). Improving Student's Mathematical Problem Solving Skills through Quizizz. Journal of Research and Advances in Mathematics Education, 5(3), 276–288. https://doi.org/10.23917/jramathedu.v5i3.10696

Simanjuntak, M. P., Hutahaean, J., Marpaung, N., & Ramadhani, D. (2021). Effectiveness of Problem-Based Learning Combined with Computer Simulation on Students' Problem-Solving and Creative Thinking Skills. International Journal of Instruction, 14(3), 519–534. https://doi.org/10.29333/iji.2021.14330a

Sinaga, B., Sitorus, J., & Situmeang, T. (2023). The influence of students' problem-solving understanding and results of students' mathematics learning. Frontiers in Education, 8, 1088556. https://doi.org/10.3389/feduc.2023.1088556

Sukmawati, R. A., Pramita, M., Wiranda, N., Mahmudah, N., & Putri, A. A. (2022). Development of interactive multimedia as support in learning mathematical problem solving for junior high schools. International Journal of Innovative Science and Research Technology, 7(8), 945–951.

Suparman, S., Yohannes, Y., & Arifin, N. (2021). Enhancing mathematical problem-solving skills of Indonesian junior high school students through problem-based learning: a systematic review and meta-analysis. Al-Jabar: Jurnal Pendidikan Matematika, 12(1), 1–16. https://doi.org/10.24042/ajpm.v12i1.8036

Surur, M., Degeng, I., Setyosari, P., & Kuswandi, D. (2020). The Effect of Problem-Based Learning Strategies and Cognitive Styles on Junior High School Students' Problem-Solving Abilities. International Journal of Instruction, 13(4), 35–48.

Syarifah, T. J., Nikmaturrohmah, P., & others. (2021). Profile of Students' Problem-Solving Skills Viewed from Polya's Four-Steps Approach and Elementary School Students. European Journal of Educational Research, 10(4), 1625–1638. https://doi.org/10.12973/eu-jer.10.4.1625

Torres-peña, R. C., Peña-gonzález, D., Lara-orozco, J. L., Ariza, E. A., & Vergara, D. (2025). Enhancing Numerical Thinking Through Problem Solving : A Teaching Experience for Third-Grade Mathematics. 1–27. https://doi.org/10.3390/educsci15060667

Tursynkulova, E., Madiyarov, N., Sultanbek, T., & Duysebayeva, P. (2023). The effect of problem-based learning on cognitive skills in solving geometric construction problems: a case study in Kazakhstan. Frontiers in Education, 8, 1284305. https://doi.org/10.3389/feduc.2023.1284305

Ukobizaba, F., Nizeyimana, G., & Mukuka, A. (2021). Assessment Strategies for Enhancing Students' Mathematical Problem-Solving Skills: A Review of Literature. Eurasia Journal of Mathematics, Science and Technology Education, 17(3). https://doi.org/10.29333/ejmste/9728

Ulya, H., Sugiman, R. R., & Retnawati, H. (2024). Technology-based learning interventions on mathematical problem-solving: a meta-analysis of research in Indonesia. Int J Eval \& Res Educ ISSN, 2252(8822), 8822. https://doi.org/10.11591/ijere.v13i1.26380

Utomo, D. P., & Syarifah, D. L. (2021). Examining mathematical representation to solve problems in trends in mathematics and science study: Voices from Indonesian secondary school students. International Journal of Education in Mathematics, Science and Technology, 9(3), 540–556. https://doi.org/10.46328/ijemst.1685

Wei, X., Cheng, I.-L., Chen, N.-S., Yang, X., Liu, Y., Dong, Y., Zhai, X., & Kinshuk. (2020). Effect of the flipped classroom on the mathematics performance of middle school students. Educational Technology Research and Development, 68(3), 1461–1484. https://doi.org/10.1007/s11423-020-09752-x

Wijnia, L., Noordzij, G., & Arends, L. R. (2024). The Effects of Problem - Based , Project - Based , and Case - Based Learning on Students ' Motivation : In Educational Psychology Review (Vol. 36, Issue 1). Springer US. https://doi.org/10.1007/s10648-024-09864-3

Yasin, M., Fakhri, J., Faelasofi, R., Safi'i, A., Supriadi, N., Syazali, M., Wekke, I. S., & others. (2020). The effect of SSCS learning model on reflective thinking skills and problem solving ability. European Journal of Educational Research, 9(2), 743–752. https://doi.org/10.12973/eu-jer.9.2.743

Yuniari, D. P., Suarjana, I. M., & Jayanta, I. N. L. (2025). Animation Video Based on Balinese Ethnomathematics on Flat Buildings Material. Jurnal Ilmiah Sekolah Dasar, 9(1), 42–52. https://doi.org/10.23887/jisd.v9i1.91497

Zulnaidi, H., Heleni, S., Syafri, M., & others. (2021). Effects of SSCS Teaching Model on Students' Mathematical Problem-Solving Ability and Self-Efficacy. International Journal of Instruction, 14(1), 475–488. https://doi.org/10.29333/iji.2021.14128a

Zulnaidi, H., Oktavika, E., & Hidayat, R. (2020). Effect of use of GeoGebra on achievement of high school mathematics students. Education and Information Technologies, 25(1), 51–72. https://doi.org/10.1007/s10639-019-09899-y