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"Ajarin" mobile: A mobile technology-based learning application to improve students' mathematical understanding

Hera Deswita[1*], Muhammad Japar[2], Etin Solihatin[2]
[1]Department of Mathematics Education, Universitas Pasir Pengaraian, Riau, Indonesia
[2]Department of Educational Technology, Universitas Negeri Jakarta, Jakarta, Indonesia
[*]Correspondence: heraiwit18@gmail.com

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Abstract

Several previous studies have tried to develop mathematics learning applications, but they are still limited as a learning medium. Developing a digital-based mathematics learning application that facilitates learning from start to finish is necessary. This study aims to develop a viable and effective mobile application. The Development Process uses the CAI design model, which includes needs assessment, design, and development & implementation. Formative evaluations were obtained from expert reviews and students. The experts involved are experts in content, learning media, and multimedia. The formative evaluation stage by students includes one-to-one trials, small groups, and field trials. Research data was collected through questionnaires and test questions. This study involved 1 teacher and 52 high school students in Indonesia. The average score of expert reviews is 3.6, which is in the category of very good. The average score obtained from Formative Evaluation by students is 3.5, with an excellent category. The pretest and post-test scores showed an increase of 40% in students who achieved the completeness of learning outcomes. The average score of N-gain is 0.4 in the medium category. The Ajarin Mobile Application is feasible and effective in improving students' mathematics learning outcomes. This research is expected to be an alternative digital learning resource that makes it easier for teachers to facilitate mathematics learning in schools.

Keywords:
Mathematics learning, Mobile application, Mobile learning

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1. INTRODUCTION

Current math learning is undergoing significant changes and innovations, particularly with the integration of digital technology and more interactive approaches (Boadu & Boateng, 2024). For instance, the Merdeka Curriculum in the Indonesia aims to provide students with a deeper understanding of mathematical concepts and their applications by using digital technology in mathematics learning (Zafirah et al., 2023). Application of digital technology-based learning can enhance students' mathematical

knowledge and problem-solving skills compared to traditional learning methods (Cóndor-Herrera & Ramos-Galarza, 2021). A learning environment supported by digital technology can enhance a deeper understanding of complex concepts, making the learning process easier and fostering students' enthusiasm for learning (Cirneanu & Moldoveanu, 2024). Moreover, the integration of technology in learning is crucial to developing students' technological skills and plays a huge role in their professional future and quality of life (Rodrigues et al., 2021). With digital technology, students can directly access information via the internet (Ford, 2018). Thus, a digital learning medium is needed to facilitate mathematics learning.

One of the media based on digital technology that teachers can adopt in designing math learning is mobile devices. The use of mobile devices to access learning content is called mobile learning (Goksu, 2021). Mobile Learning is electronic learning delivered through mobile computing devices (Wishart, 2017). The use of mobile devices can provide convenience for students because it has small dimensions, instant response in its use (Fojtik, 2014). The use of mobile technology can increase student engagement in exploring concepts through available learning resources (Fabian et al., 2018) so that it can improve students' mathematics learning outcomes (Yunianta et al., 2019). The results of the study show that mobile learning is one of the effective ways to facilitate mathematics learning (Yosiana et al., 2021). A variety of digital learning resources, such as videos, can be easily input and accessed on mobile devices (Churchill, 2017). Research shows that videos available in mobile technology are more effective in helping students learn (Reddy et al., 2021). The use of video has proven to provide satisfaction in students' mathematics learning (Nagy, 2018). The availability of videos can make it easier for students to repeat the material according to their respective speeds (Murphy et al., 2022).

Several previous studies have developed mathematics learning applications based on mobile technology. Examples of applications that can be operated through mobile devices are WhatsApp, ProveIt, Augmented Reality, Ubiquitous Geometry (UG) App, and GeoGebra. One of the learning applications that is widely used during covid is WhatsApp (Azer et al., 2023). Although the use of WhatsApp in mathematics learning has advantages, it has many challenges in organizing learning (Campbell, 2019). ProveIt is an Android-based mobile app that provides students with visual representations and interactive learning technologies to understand theorem proofs on triangles (Verzosa et al., 2019). The results of their research show that ProveIt is able to facilitate students' skills in proving geometry. Augmented Reality (AR) is an application that is still hotly talked about today in its immersion in mathematics learning. AR can improve students' ability to learn math and provide an engaging visual experience that can visualize abstract concepts (Chen, 2019) and is able to improve students' creative thinking skills (Hidajat, 2024). Ubiquitous Geometry (UG) App is a learning app designed to help students learn geometry concepts. The implementation of the UG App provides positive results on learning achievement, learning effectiveness and student learning quantity (Hwang et al., 2021). GeoGebra is an application that is currently prevalent and often used in mathematics learning. GeoGebra is a free and multi-platform dynamic math software for all levels of Education. Many studies have shown the efficacy of the application of GeoGebra in improving students' learning experience, performance and mathematics learning outcomes (Ferdiánová, 2017; Manganyana et al.,

2020; Radović et al., 2020; Yohannes & Chen, 2023). However, the application is still limited as a learning medium. These applications do not provide more complete features such as motivation, description of mathematical content, videos, reflection and assessment so that they cannot facilitate learning activities from start to finish. A mobile app designed to make learning more organized and integrated so that it can allow students to learn flexibly, anytime and anywhere (Camilleri & Camilleri, 2023).

In this study, the mobile application to be developed is called Ajarin Mobile. Ajarin mobile has four main menus including content, media, discussion and score. The uniqueness of the Ajarin Mobile application is that it provides features that allow students to learn more organized and easier. The syntax of mathematics learning consists of four steps, namely Harmonization, Exploration, Reflection and Assessment. Each syntax has its own features. The harmonization feature can allow any student to generate motivation through video. Motivation is one of the biggest factors that can arouse students' enthusiasm to carry out meaningful and useful learning activities (García et al., 2023). The exploration feature serves for core learning activities. This feature provides various supporting facilities in the form of worksheets, videos and other mathematical media software. Using various tools in mathematics learning can increase students' chances of exploring in solving math problems (Koyunkaya & Dede, 2024). Reflection features are provided so that students have the opportunity to present their understanding of learning activities (Ingulfsen et al., 2023). Meanwhile, the Assessment Feature is for working on multiple-choice questions and essays. In addition, it also provides a discussion feature in the form of a chat box that can allow all students and teachers to interact with each other personally or in their groups.

The purpose of this study is to determine the feasibility and effectiveness of the application to students' mathematics learning outcomes. On the mobile application, learning resources are available as a supporting system such as a brief description of teaching materials, learning videos and appropriate student worksheets. Student Worksheets function as a supporting tool to facilitate learning activities the success of the implementation of the learning process undeniably requires the provision of effective learning resources. Engaging worksheet visualization can foster students' enthusiasm for learning experiences (Sutarni et al., 2024). In the development process, this mobile application pays attention to learning navigation that is easy for students to follow so that it is expected to have a positive impact on students' mathematics learning. Assessment of learning outcomes is also carried out integrated in the mobile application. Assessments are carried out individually so that feedback can be obtained automatically by students but still consider the total assessment according to the student's mathematical ability (Weigand et al., 2024).

2. METHOD

2.1. Type and Research Design

Based on the purpose of the research, this study is a research and development (R&D) which aims to produce a measurable and usable product (Dahal et al., 2023). This study uses the Computer-Assisted Instruction (CAI) Design Model which is a development model to produce instructonal software consisting of 3 main phases including needs assessment, design, and development & implementation (Hannafin & Peck, 1988). Each of these three

phases undergoes a continuous evaluation and revision process until it produces the expected product (see Figure 1).

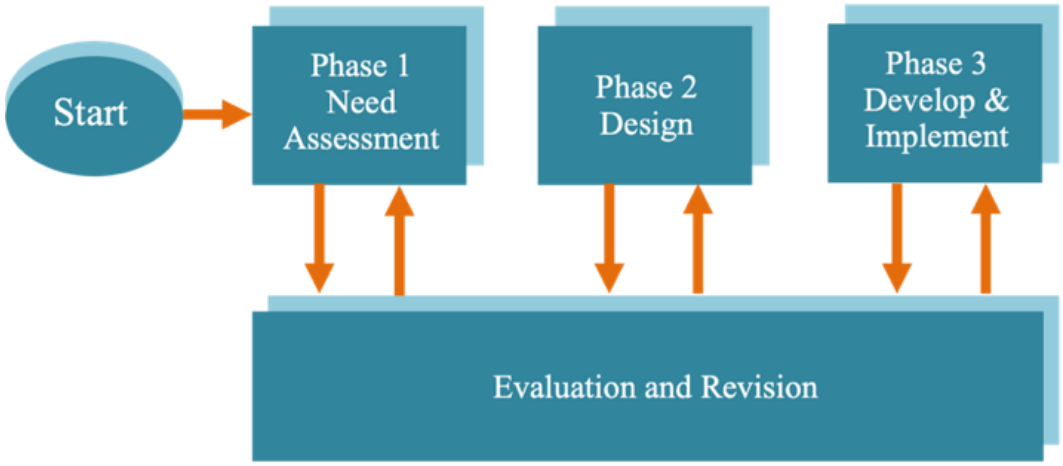

Figure 1. Computer-asissted instruction (CAI) design model

Each phase of development has its purpose. The purpose of the needs assessment is to clearly define the specifications of the product to be developed. In this phase, information is collected about student characteristics, content and environmental context. This information is a consideration for the development of mobile applications to be appropriate and on target. The purpose of the design phase is to identify and document the best way to produce the required Mobile application. The activity in the design phase is to design mobile application software. The purpose of the develop phase is to thoroughly evaluate the mobile application. Aspects assessed include Instruction Adequacy, Cosmetic Adequacy, Program Adequacy, and curriculum Adequacy (Hannafin & Peck, 1988). In this phase, a formative evaluation is carried out to obtain the feasibility of the mobile application (Lo et al., 2024).

The first formative evaluation is an expert review which includes two content experts, one learning media experts and two multimedia experts. The content expert has a background in mathematics education and has a doctoral degree. The learning media expert has a background in instructional technology and holds a doctoral degree. Meanwhile, multimedia experts have expertise in the field of UI/UX design and have a master's degree. Content experts assess the adequacy of instructional and curriculum, learning media experts assess all aspects, while multimedia experts assess the adequacy of cosmetics and programs. The function of formative evaluation by experts is to conduct assessments and give suggestions (see Figure 2), so that researchers can make revisions so that the products produced are effective and attractive (Tessmer, 2013). Formative evaluation by users (students) is carried out in three stages, namely one-to-one, small group and field trial (Dick et al., 2014; Hannafin & Peck, 1988). The purpose of the implementation phase is to test its feasibility and effectiveness (Gadke et al., 2021).

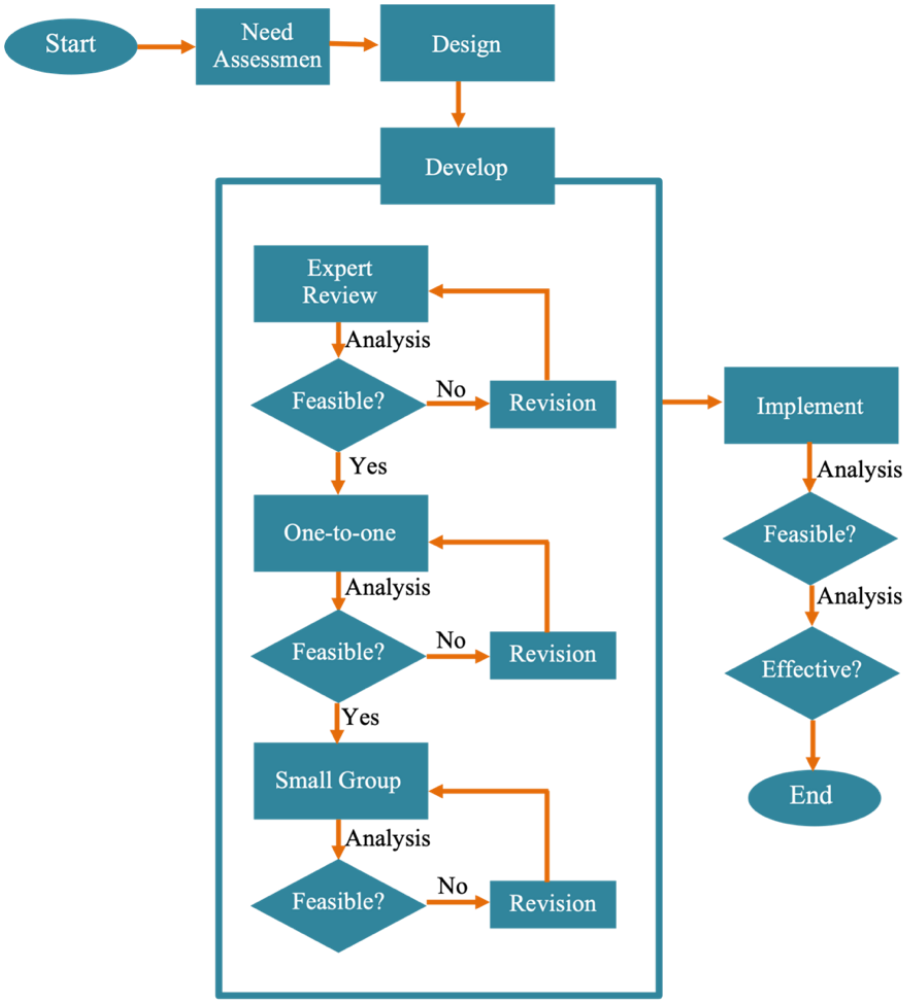

Figure 2. Research procedure

2.2. Research Setting

A total of 52 high school 10th grade students and 1 mathematics teacher from one of the schools in Indonesia participated in this study. The details of the participating students were: The one-to-one evaluation involved 3 students, the small group involved 9 students, and the field trial involved 42 students, all of whom were different students.

2.3. Instrumentations and Data Analysis Technique

The instrument used for formative evaluation by experts is a questionnaire adapted from the CAI model (Hannafin & Peck, 1988). Aspects assessed by experts include instruction adequacy, cosmetic adequacy, program adequacy, and curriculum adequacy. Experts judge by giving a score between 1 to 4; Strongly disagree (1), disagree (2), agree (3), and strongly agree (4). The scores obtained from the experts are averaged and then interpreted to get the assessment category.

Table 1. The feasibility categories of mobile applications

Average Score	Category
3.5 – 4	Very Good
2.5 – 3.4	Good
1.5 – 2.4	Fair
≤ 1.4	Poor

The instruments used for formative evaluation by users (students) are questionnaires and interviews. Interviews are conducted to ask for students' responses and suggestions so as to deepen the data obtained. The questionnaire data analysis also uses Table 1. The Mobile application is declared suitable for use if the average score is at least 2.5.

The instrument used to measure the effectiveness of learning is the mathematical comprehension test question. Students were given 6 essay questions consisting of one C2 cognitive level question (understanding), two C3 cognitive level questions (application), one C4 cognitive level question (analysis), one C5 cognitive level question (evaluation) and one C6 cognitive level question (Create). The assessment technique is carried out proportionally with a maximum score of 100. Internal validation is carried out by three mathematics education experts who have doctoral degrees and have experience in mathematics education research. The type of validity is the validity of the content where the questions are compared with the question grid according to the curriculum (Utomo, 2019). Furthermore, external validation was carried out by piloting test questions to 30 students who were different from the research subjects. Questions are categorized as valid with the criteria of r calculation > r-table (Ajizah et al., 2023). The reliability test results obtained a score of 0.79 in the high category. The instrument validation process in this study follows the mechanism visualized in Figure 3.

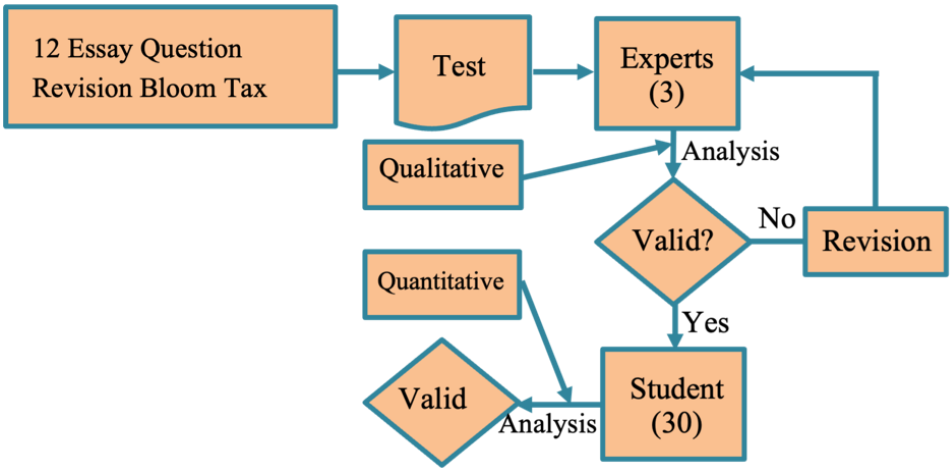

Figure 3. Instrument validation process

To find out the effectiveness of the implementation of the mobile application, students are given a pretest at the beginning of learning. After all the learning is complete, students are given a post-test. The minimum completeness criterion score is 76 with a grade of B. Learning effectiveness is known by analyzing the N-gain score (Wahyudin et al., 2019).

N-gain's score was calculated using SPSS 29. The interpretation of the N-gain score uses the criteria in Table 2. The implementation of learning is said to be effective if the N-gain score is at least 0.3 in the medium category (Muhtarom et al., 2019).

Table 2. Interpretation of N-gain score

N-gain Score	Category
$g \geq 0.7$	High
$0.3 \leq g < 0.7$	Medium
$g < 0.3$	Low

3. RESULTS AND DISCUSSION

3.1. Needs Assessment

Students in the 10th grade of high school are Generation Z who are considered quick to adapt to technology (Yalçin-Incik & Incik, 2022). Generation Z is known as a digital native who was born with technology (Hernandez-de-Menendez et al., 2020). In their daily lives, they are used to interacting with mobile technology (Wawer et al., 2022). However, students still learn by using heavy and thick textbooks. Based on observations of learning activities in the classroom, mathematics teachers at the research site only used the GeoGebra application for teaching needs by presenting in front of the class while students were not directly involved in using the GeoGebra application.

The context of the environment strongly supports the implementation of mobile learning. Based on the survey results, all students have their own mobile devices (Smartphones). Based on teacher interviews, information was obtained that students are allowed to bring mobile devices if they are used for learning needs. The internet network around the school area is excellent as it is in the city center. Thus, the use of mobile applications is suitable for implementation. Students can engage in using digital technology in acquiring mathematical knowledge and skills.

Furthermore, a curriculum analysis is carried out to determine the content that will be presented on the mobile application. In the Merdeka Curriculum, grade 10 students are in phase E. The element chosen is the geometry with the topic of trigonometry. The learning objectives achieved by students in this material can be seen in the Table 3.

Table 3. Trigonometric learning objectives flow

Element	Learning Outcomes	Learning objectives
Geometri	At the end of phase E, students can solve the problem of right triangles involving trigonometric comparisons and their applications	1. Students are able to name the sides of a right triangle according to the angle of the triangle correctly. 2. Students are able to use the concept of tangent trigonometric comparison in solving everyday problems correctly. 3. Students are able to use the concept of sinus trigonometry comparison in solving everyday problems correctly

Element	Learning Outcomes	Learning objectives
		4. Students are able to use the concept of cosinus trigonometric comparison in solving everyday problems correctly 5. Students are able to analyze and explain why the value of an angular trigonometric comparison can always be the same by using the GeoGebra simulation correctly 6. Students are able to create a simple clinometer design to find the right solution to everyday problems

3.2. Design

This mobile application is called "Ajarin Mobile". The mobile application is built using the Flutter framework with the dart programming language (see Figure 4). Development of mobile application through Flutter offers excellent performance (Souha et al., 2024; Uplenchwar et al., 2022). Flutter offers a convenience for user updates without going through the Google Play Store or Apple App Store (Biørn-Hansen et al., 2020).

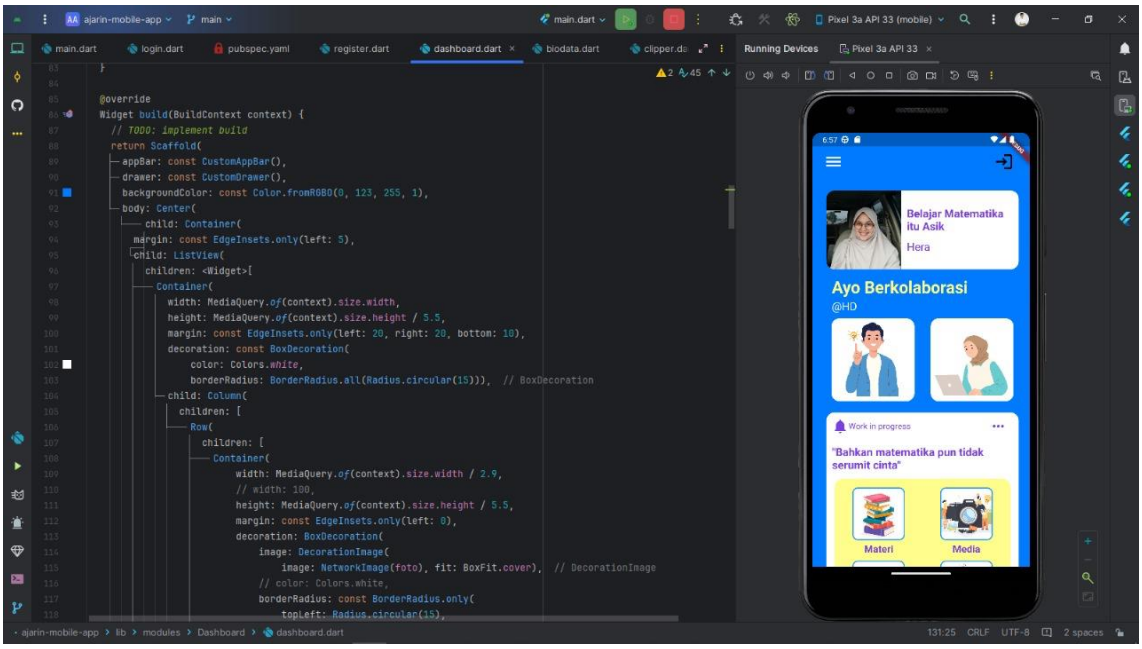

Figure 4. Layout of Ajarin mobile design using flutter

The developed Ajarin Mobile application provides ease of navigation. The movement from one page to another was created so as not to cause confusion for students. The following is the navigation design of the Ajarin Mobile application (see Figure 5).

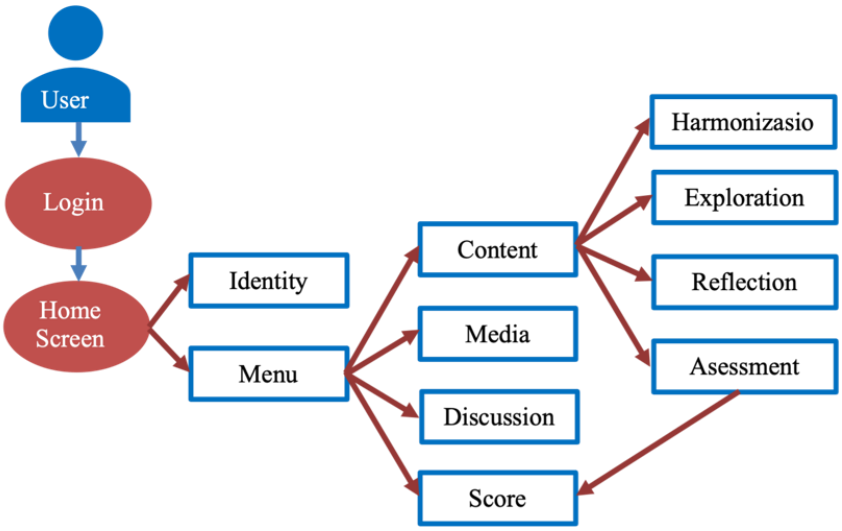

Figure 5. Navigation design of the Ajarin mobile application

The "Ajarin Mobile" application can facilitate learning from the beginning to the end. Students log in to the Ajarin Mobile application using the Student Identification Number as username and password. After the student successfully logs in, then move to the home screen page. The home screen contains the student's identity and the main menu which includes *Materi*, *Media*, *Diskusi*, and *Nilai* (in Bahasa). The core learning activities are found in the *Materi* menu. In the *Materi* menu, there is a display of the Harmonization, Exploration, Reflection and Assessment buttons on the right edge of the screen (see Figure 6).

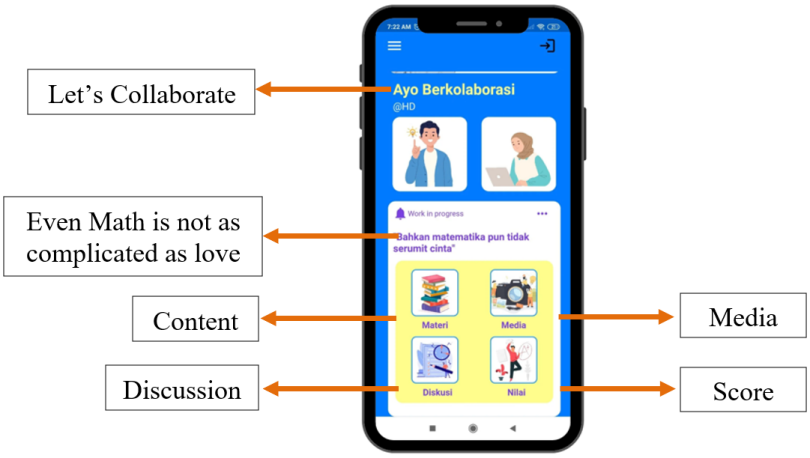

Figure 6. Home screen of the Ajarin mobile application

The Harmonization button is used for activities to motivate students. Students watch motivational videos that have been provided so that they are enthusiastic about learning mathematics. The Exploration button contains a description of mathematics concepts, relevant learning videos, student worksheets and examples of contextual math problems. In this exploration section, there is a button to upload documents in JPG or PDF format. After the exploration activity is over, each student conveys what they have and have not understood during the learning on the reflection button. Students can type in the reflection

column. The assessment button contains questions in the form of multiple choice and open-ended. Students can see the results of multiple-choice answers after submitting the question on the Nilai menu.

3.3. Develop and Implementation

The initial stage of the development phase is to conduct an expert review. The experts install the Ajarin mobile application and fill out the questionnaire given. In the expert review process, intense discussions are held to ask for criticism and suggestions. Aspects assessed by experts include Instruction Adequacy, Cosmetic Adequacy, Program Adequacy, and curriculum Adequacy (Hannafin & Peck, 1988). The role of expert assessment in the development of learning models is a critical and diverse topic that has far-reaching implications for developing learning models. Revisions are carried out repeatedly so that the Ajarin Mobile Application that meets the Feasibility criteria is obtained. Table 4 is the result of the review by experts.

Table 4. Results of expert review of Ajarin mobile application

Type of Adequacy	Statement	Average	Category
Instruction	Clarity of vocabulary used in trigonometric content	4.0	Very Good
	Clarity of sentence complexity in trigonometric content	3.3	Good
	Clarity of the structure of trigonometric content	4.0	Very Good
	Clarity of the relationship between the context of trigonometric content and examples and non-examples	3.7	Very Good
	Clarity of the relationship between the context of trigonometric content and analogy	3.3	Good
	Clarity of the relationship between the context of trigonometric content and illustration	3.3	Good
	Clarity of the relationship between the context of trigonometric content and demonstration	3.7	Very Good
	Clarity of the sequence of trigonometric content	4.0	Very Good
	Clarity of the size of the segments of the trigonometric content presented	3.7	Very Good
	Clarity of transitions between segments of trigonometric content	3.7	Very Good
	Clarity of variation in the presentation of trigonometric content	3.3	Good
Cosmetic	The screen available on Ajarin Mobile is used optimally	3.7	Very Good
	The screen of the Ajarin Mobile application has a reasonable density	4.0	Very Good
	There is a consistent and effective protocol for each frame	3.7	Very Good
	Presentation of content free from the crowd of information	3.7	Very Good
	Element layout on the Ajarin Mobile Application is proportional	3.3	Good
	The appearance of the Ajarin Mobile Application is clear	3.3	Good

Type of Adequacy	Statement	Average	Category
	The appearance of the Ajarin Mobile Application is attractive	3.0	Good
	Trigonometric content typed correctly	3.7	Very Good
	The choice of type and size of the font is appropriate	3.3	Good
	Color and sound support trigonometric content	3.3	Good
	The use of images and colors in the Ajarin Mobile Application is interesting	3.3	Good
	Animation supports trigonometric content	3.7	Very Good
	The Frame of the Mobile Teaching App is free from scrolling effects	3.3	Good
	Learning activities are presented attractively	3.3	Good
Program	The Ajarin Mobile application can be operated	4.0	Very Good
	Users can easily log in to the Ajarin Mobile Application	4.0	Veru Good
	Ajarin Mobile application is safe to use	3.7	Very Good
	Interface design provides easy-to-operate navigation	3.7	Very Good
	Navigation of the Ajarin Mobile Application runs effectively	3.7	Very Good
	The Ajarin Mobile application has a clear navigation structure	4.0	Very Good
	The navigation structure of the Ajarin Mobile App is easy to use	3.7	Very Good
	The navigation flow of the Ajarin Mobile Application is good	3.3	Good
	The elements layout of the Ajarin Mobile Application is logical and systematic	3.0	Good
	The Ajarin Mobile application provides facilities to receive student responses	3.7	Very Good
Curriculum	Trigonometry content in accordance with the Merdeka Curriculum	4.0	Very Good
	The learning syntax is consistent	4.0	Very Good
	Trigonometric material is relevant for high school students	4.0	Very Good
	Trigonometric content presented up to date	3.0	Good
	Learning can be completed within the allotted time.	3.3	Good
	Average	**3.6**	**Very Good**

Based on Table 4, the average expert review is at 3.6 (Very Good). Thus, it can be stated that the Ajarin Mobile application is feasible according to experts and can be continued to a one-to-one evaluation.

The participants of the one-to-one evaluation involved three students, each consisting of students with high, medium and low abilities based on the student's initial ability test. Students are asked to install the Ajarin Mobile application on the Play Store. Students run the app, read, and study the available material. Students play videos, use GeoGebra, and do student worksheets. Students are asked to check the features available in the Ajarin Mobile

application. The students were interviewed about their responses to the Ajarin Mobile application.

Based on the results of the interview, several opinions can be summarized. Students stated that the trigonometry material on the Ajarin Mobile application is clear and easy to understand. The learning sequence is easy to understand. Students find some typos in words and sentences that make them difficult to understand. Students stated that the quality of the Ajarin Mobile application was attractive. Students suggest changing the appropriate colors in some features. Based on suggestions from students, minor revisions were made. After the revision, then a Small Group evaluation was carried out.

Small group evaluations are carried out like real classroom learning. This stage involves one teacher and nine students, each consisting of 3 students with high, medium, and low abilities. Students are organized into three heterogeneous groups. The purpose of this small group evaluation was to find out if the Ajarin Mobile application can work well in collaborative mathematics learning in the classroom. The learning took place in 3 meetings. Furthermore, students are asked to fill out a questionnaire and give recommendations related to the Ajarin Mobile application that they have used.

Based on Table 5, the average of the small group evaluation is 3.5 (Very Good). Students suggested that the learning videos be more complete and add examples of relevant practice questions. Students are very interested in the Ajarin Mobile application because it has an attractive and easy-to-use interface without having to carry heavy textbooks. Thus, it can be said that Ajarin Mobile is worthy of being implemented in actual learning through field trials.

The field trial is to carry out actual learning activities that involve one teacher and 42 students. Students are divided into heterogeneous groups, each with a composition of students with high, medium, and low abilities. Learning was carried out in 6 meetings. This stage aims to ask for student responses and find out the effectiveness of the Ajarin Mobile application on students' mathematics learning outcomes.

Figure 7. Student learning activities by Ajarin mobile

The implementation of the Ajarin Mobile application in mathematics learning was carried out well. Students can follow the learning easily even though there are few obstacles. The obstacles found include the lack of carrying capacity of students' mobile devices so that the application does

not run optimally. After deleting several game applications, the Ajarin Mobile application can be used smoothly again. In addition, students are less skilled in converting files into PDF form. Students are not used to using GeoGebra, so it takes extra time to operate it. These obstacles occurred at the first meeting. Based on observations (see Figure 7), students seem enthusiastic about learning mathematics collaboratively using the Ajarin mobile application. As beginners in using mobile application-based learning media, students help each other to understand how to use the application in their group. Students who have difficulty operating the application will ask students who can do so. Thus, it can be stated that the implementation of the Ajarin Mobile application can cause engagement and interaction between students in mathematics learning. Student responses in the field trial to the Ajarin Mobile application were also obtained. Based on Table 5, the average field trial evaluation is 3.5 (Very Good). Thus, it can be stated that the Ajarin Mobile application is feasible.

Table 5. Results of small group and field trial evaluation

No	Statement	Average	
		Small Group	Field Trial
1	The vocabulary used in trigonometric content is clear	3.9 (Very Good)	3.6 (Very Good)
2	The complexity of sentences in trigonometric content can be understood	3.4 (Good)	3.5 (Very Good)
3	The relationship between the context of trigonometric content with examples and non-examples is clearly presented	3.6 (Very Good)	3.6 (Very Good)
4	The sequence of trigonometric content is clearly arranged	3.7 (Very Good)	3.7 (Very Good)
5	Trigonometric content has relevance/benefits	3.8 (Very Good)	3.7 (Very Good)
6	Students easily understand Trigonometry content	3.3 (Good)	3.2 (Good)
7	Students are satisfied with learning trigonometry content	3.2 (Good)	3.3 (Good)
8	Students can complete learning using the Ajarin Mobile application according to the allotted time	3.3 (Good)	3.4 (Good)
9	The Ajarin Mobile application supports student interaction	3.6 (Very Good)	3.5 (Very Good)
10	Ajarin Mobile application increases student learning motivation	3.6 (Very Good)	3.5 Very Good
11	The appearance of the Ajarin Mobile application is attractive	3.4 (Good)	3.4 (Good)
12	The choice of type and font size is right	3.3 (Good)	3.5 (Very Good)
13	The layout of elements on the Ajarin Mobile application is proportional	3.4 (Good)	3.4 (Good)
14	The use of images and colors in the Ajarin Mobile application is interesting	3.6 (Very Good)	3.5 (Very Good)

The final activity in the implementation phase is to test the effectiveness of the Ajarin Mobile Application on student learning outcomes. Based on Figure 8, 40 (95%) students obtained an increase in learning outcomes. Although there is an increase, there are still some students who have not reached the minimum completeness score.

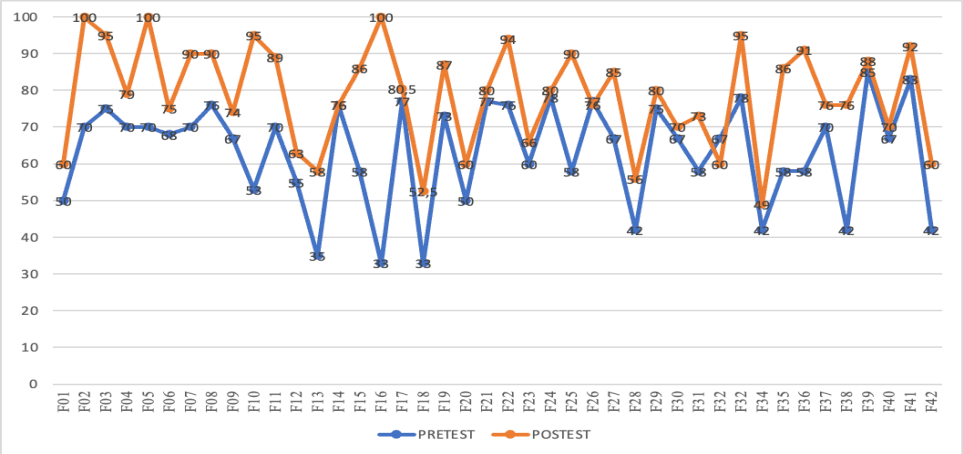

Figure 8. Pretest and post-test scores

Table 6 shows the percentage of students who completed (Grades A and B) before using the Ajarin mobile application was 24%, while after using the Ajarin Mobile application was 64%. This shows an increase in the percentage of students who complete by 40%.

Table 6. Completeness of learning mathematics using the Ajarin mobile application

Grade	Pretest	Post-test
A	0 (0%)	17 (40%)
B	10 (24%)	10 (24%)
C	15 (36%)	6 (14%)
D	6 (14%)	7 (17%)
E	11(26)	2 (5%)

The N-gain Score Test was conducted to determine the effectiveness of using the Ajarin Mobile application. The average score of N-gain is 0.4 with a moderate category (see Table 7). Thus, it can be said that the Ajarin Mobile Application is effectively used in mathematics learning.

Table 7. N-gain score of student mathematics learning outcomes

	N	Minimum	Maximum	Mean	Std. Deviation
N-gain Score	42	-0.21	1.00	0.4101	0.31491
Valid N (Listwise)	42				

Today, mathematics learning has evolved from a traditional setting to one that utilizes digital technology. Educators and students should adapt to digital technology in the mathematics learning process. Digital resources are a learning tool that can strengthen the learning process (Lazaro & Duart, 2023). In this study, the development of a learning application based on mobile technology was carried out. This application contains menus and features that can facilitate students to learn easily. This mobile application is tested in mathematics learning. Formative evaluation has been carried out by experts and students so that the feasibility of products with very good categories is obtained. The results of the

implementation show that the Ajarin Mobile application is effective in students' mathematics learning outcomes. Although its effectiveness is in the medium category, the adoption of technology in learning has been carried out. Students are already actively involved in adapting technology in mathematics learning. However, the implementation of the Ajarin Mobile application in collaborative learning is only limited to face-to-face settings. Online collaborative learning is still difficult to do (Bringula & Atienza, 2023). The findings of this study show that the use of the Ajarin Mobile application in Mathematics learning has the potential to provide great benefits for students. The mobile application allows students to learn anytime, anywhere and according to the characteristics of current students (Yaniawati et al., 2022). The development of the Ajarin Mobile application is beneficial because it can make it easier for students to learn. Mobile apps can help students who have high curiosity to explore new concepts (Kashive & Phanshikar, 2023). The application of mobile applications in mathematics learning is effective in improving students' understanding and mathematical abilities (Rohaeti et al., 2023). The use of Mobile technology in learning allows students to acquire a wealth of information and resources to solve problems (Grant, 2019). It is important for educators as facilitators in the implementation of learning and policymakers to continue to explore and apply Mobile Applications in mathematics learning (Tezer & Gülyaz, 2022). Educators need to make careful preparations so that the use of mobile applications can be carried out optimally in learning (Sharafeeva, 2022). Same as previous research (Zhampeissova et al., 2020), In this study, it is also proven that the implementation of Mobile Applications in collaborative mathematics learning provides good effectiveness. To provide better effectiveness and there is a significant improvement, the development of the Ajarin Mobile application will continue to be carried out. The provision of menus and features on the Ajarin Mobile application that are useful in learning mathematics can be done continuously (Daher & Baya'a, 2012).

The development of the Ajarin Mobile application has weaknesses. Needs analysis and providing learning features must be done more critically and in-depth. The implementation of the application must be carefully prepared so that it is easy for students to operate. Thus, we recommend the next study to carry out a more comprehensive development of this Mobile application.

4. CONCLUSION

The development of the Ajarin Mobile Application has been carried out using the CAI design model. Formative evaluation by experts includes instructional, cosmetic, program and curriculum adequacy. The results of the expert review stated that the Ajarin Mobile application has a very good feasibility of being used in mathematics learning. Formative evaluation by students includes one-on-one getting some input as a revision consideration. The questionnaire results of the small group and field trial also stated that the Ajarin Mobile application was very good. The results of the prestest and post-test showed that there was an increase in students' mathematics learning outcomes. Thus, it can be concluded that the Ajarin Mobile application is feasible and effective to be used in mathematics learning.

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Declarations

Author Contribution : HD: Conceptualization, Writing - Original Draft, and Editing and Visualization; MJ: Methodology; ES: Validation and Supervision.

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