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3. Readability	3.0
4. Soundness of methodology	4.5
5. Evidence supports conclusion	4.5
6. Adequacy of literature review	4.5
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❖ Strengths

The paper entitled "AN ASSISTIVE TECHNOLOGY TO ENHANCE CONJECTURING ABILITIES OF SLOW LEARNERS: A MOBILE APPLICATION DESIGN" provides a detailed insight of recent emerging issues and in my view the above title is suitable for publication in RM.

❖ Weaknesses

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  b. Focus on the formatting of the document.
  c. APA style of referencing is required.

AN ASSISTIVE TECHNOLOGY TO ENHANCE CONJECTURING ABILITIES OF SLOW LEARNERS: A MOBILE APPLICATION DESIGN

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Abstract

The variability of students' skill in conjecture is one of the challenges math teachers have when teaching number pattern topics. This is demonstrated by the errors made by students when examining a case, categorizing it, searching for, identifying patterns, and formulating conjecture. Four students were identified as slow learners after a series of assessments. As a result, a technology that can be used as an aid (assistive technology) was required. This project intended to create a mobile learning-based application that can be an aid for students who struggle to learn, especially when it comes to understanding material about numerical patterns. This study employs a design-based research paradigm with four phases, including 1) requirements analysis of real-world issues; 2) problem-solving development; 3) design of mobile learning applications, and 4) reflections and documentation of findings. The design of mobile-learning application has been generated from this research, which can then be used to create mobile learning-based application product.

Keywords: Conjecturing, Assistive Technology, Mobile Learning, design-based research, Students are slow learners

INTRODUCTION

One of the standards of reasoning from pre-kindergarten to high school is to create and investigate mathematical conjectures [1]. Making conjectures is important because it serves as a basis for developing new insights and increasing further studies. Creating and investigating conjectures is one of the stages of mathematical discovery [2] and mathematical thinking [3].

A conjecture is a statement about all possible cases based on empirical facts, but with an element of doubt [4],[5]. The process of constructing the conjecture is called conjecturing process [6]. The conjecturing process is carried out through the stages of observing cases, organizing cases, finding and predicting patterns, formulating conjectures, validating conjectures, generalizing conjectures, and justifying generalizations.

Based on the results of the conjecturing ability test in a limited trial at SMP Negeri 19 Mataram, SMP 11 Mataram, MTs Nahdlatul Mujahidin, and SMPN 6 Mataram on number pattern material in 2021 (Applied Research), 45.6% of students did not succeed in constructing conjectures and after further assessment by the Institute for Psychological Consultation and Testing, Mandalika University of Education, 21.5% students were diagnosed as slow learners. The student experienced errors in observing cases, organizing cases, finding and predicting patterns, and formulating conjectures. These errors occur because one of them is a slow learner. In general, slow learner students have lower learning achievements than regular students [7][8][9].

An interview with students revealed the most common obstacles they face: 1) difficulty in understanding abstract concepts; 2) low learning motivation; 3) longer time to understand and 4) the need for repetition in the explanation of the material. The four slow learner students were Generation Z who could not be separated from smartphones and need assistive technology in their learning.

In addition, a number of Sutarto's investigations revealed that many students found it challenging to construct conjecture [4] when attempting to solve mathematical problems [5], [6], and [10]. PBL-based learning tool can help junior high school students' conjecturing skills [2]. Students with special needs may benefit from the usage of assistive technology [11–15]. According to several of these studies, no study was conducted to create assistive technology to enhance the conjecturing skills of students who struggle with learning number patterns.

Assistive technology is a technology that is specifically created to improve the ability of people with special needs to solve problems that they are unable to solve [15]. The use of assistive technology to motivate and have fun with, is carried out in a sustainable manner, facilitates students in independent learning, and helps them to complete assignments.

Based on the problems elaborated, the problem formulation in this research is the development of assistive technology to improve the conjecturing ability of slow learner students on number pattern material. Assistive technology developed is based on a mobile learning application that has popup and lock features, i.e the ability of the application to take over the smartphone screen so that users are forced to complete learning activities as scheduled. In supporting application performance, learning tools including lesson plans, teaching materials, worksheets, evaluation instruments, and video explanations of the material are needed.

The use of mobile learning is proposed in this study because its use is more simple and fun with flexible learning materials [16]. Mobile learning was first introduced in 2005 [17], then it was widely used by researchers to help learning. It has the characteristics of prioritizing ubiquitous (mobility), social interaction, and considering user personalization [18]. Mobile learning is widely defined as a technology-based or techno-centric learning aid [17][19]. The use of mobile learning is able to provide an independent learning experience for students [20].

METHODOLOGY

In this study a design-based research model is used as a framework to achieve the research objectives. This model systematically aims to develop solutions to problems faced in the real world [21]. Therefore, this model is used to produce mobile learning applications as a solution to improve the conjecture abilities of slow learners, especially for the number pattern material in mathematics. This model includes four stages: (1) requirement analysis of practical problems, (2) development of solutions to solve problems, (3) m-learning apps design, and (4) reflections and documentations of solutions.

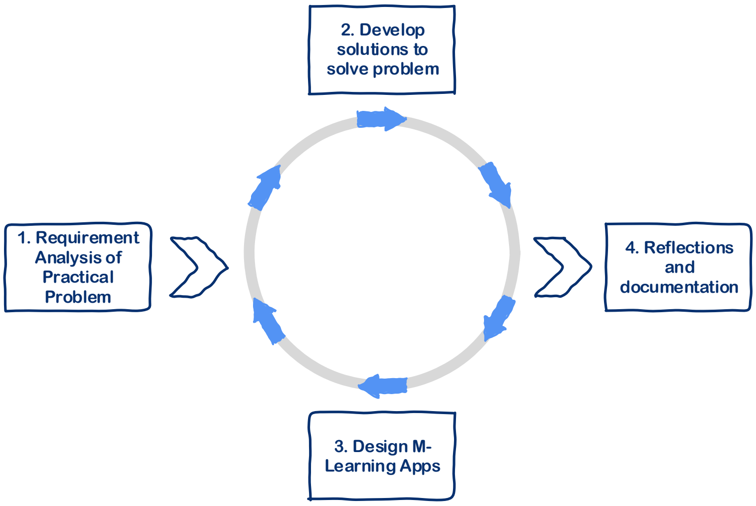

Figure 1. Design-based research model of this study

The first phase in this model is requirements of analysis of practical problems. This phase begins by formulating all the problems faced by students and teachers in understanding number pattern material. In figure 1, there are two iterative phases, namely the phase of developing solutions to solve problems and the design phase of m-learning apps. By repeating the third phase, the design of m-learning apps that meet all user needs is expected to be obtained [19]. In this study, iterations in phase 2 and phase 3 were not carried out separately, but were repeated together until the m-learning design was in accordance with the specified solution [22]. The last or fourth phase is documenting the m-learning design so that it can be used during the application development process.

RESULT AND DISSCUSSION

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Phase 1 Requirement Analysis of Practical Problem

The challenge behind the design of mobile learning application is the weak ability of most students in developing their conjecture abilities. Meanwhile, developing a conjecture is one of the stages of mathematical discovery as well as a way of thinking mathematically. A conjecturing ability test showed that 45.6 percent of students at junior high school education level failed in constructing conjectures. After further psychological assessment, it was found that 21.5 percent of students were slow learners. These results were further confirmed by interviews with students indicated as were slow learners. The the main obstacles they faced were difficulties in understanding abstract concepts, low learning motivation, requiring a long and repetitive time in understanding a concept, and indications of addiction to smartphones [23].

This is used as the basis for developing this research. The high tendency of students to use smartphones is also one of the reasons why mobile learning is chosen to help slow learners in addition to the high growth of smartphone users in Indonesia. Hotsuite (we are social): Indonesian Digital Report 2022 released data that there are 370.1 million smartphone users in

Indonesia. The use of mobile learning is still a concern for teachers because there is a tendency for students not to use the application. Therefore, it is necessary for the participation of parents to assist teachers in supervising student behavior in using the application. In addition, the application must also be able to directly force students to complete the learning process by using the application. This needs to be considered so that in the application design process it can accommodate the needs of the teachers.

Phase 2 Develop Solution to Solve Problem

Furthermore, based on the analysis of conditions and needs in phase 1, there were several points to be used to develop solutions. The proposed solution must be able to support face-to-face learning activities, improve more effective communication between teachers and students and increase student learning motivation, so that the pedagogic value of mobile learning applications can be felt. There are four basic elements that need to be considered in developing mobile learning applications, namely (1) pedagogics, (2) technology integration, (3) technical assessment, and (4) interactions between teachers and students, as well as interactions between students and students [16].

The development of mobile learning must generate pedagogical elements that are able to accommodate the needs related to blended learning, collaborative learning, and active learning [24], [25]. The solution given to the problem refers to the pedagogic model for mobile learning which is expected to be able to provide skills in Education 4.0 [16]. This model requires technological literacy skills from teachers, students, and even parents [26]. In addition to paying attention to technological literacy skills, mobile learning developed pedagogic values, in particular improving conjecturing abilities in mathematics subjects, especially number pattern material. Therefore, the developed mobile learning must accommodate pedagogic values.

Pedagogic values that need to be integrated into mobile learning are learning conditions, instructional methods, and learning outcomes. In terms of learning conditions, mobile learning applications are required to accommodate learning difficulties faced by slow learners. Meanwhile, in terms of the instructional method, the application is required to provide diverse learning content, especially those that are able to help slow learners in understanding number pattern material. Furthermore, the application must be able to provide various learning strategies for slow learners, such as learning scheduling strategies, as well as learning outcomes evaluation strategies. Eventually, the use of this mobile learning application can meet the learning outcome targets set on the number pattern material.

Utilization of mobile learning as an assistive technology for slow learners should also be able to provide opportunities for students to interact with each other, either through discussion forums or other means such as chat and the like. The teacher acts as a facilitator as well as supervising student discussion activities. Mobile learning applications must be able to provide diverse learning materials such as replayable videos and student worksheets. In addition, the learning material that is built avoids delivering material by requiring students to read for too long because reading material using a smartphone for a long time will make students bored and uncomfortable.

In the end, all student activities in using this mobile learning application can be monitored by the teacher through the student performance dashboard feature. The dashboard is able to display all student activities in real time, making it easier for teachers to carry out monitoring and evaluation. Based on the explanation above, there are four actors who use mobile learning with a description of the role of each actor as shown in table 1 below.

Table 1. Actor and Role Description

Actor	**Role Description**
Student	Completing learning activities
Teacher/Advisor	Preparing learning materials, implementing and evaluating learning
Administrator	Managing user management (students and teachers)
Parent/School Headmaster	Monitoring the progress of student learning activities

Table 2. Features of each user

User	**Feature**
Student	Scheduled lessons
	Material discussion Forum
	Student worksheets
	Popup and lock of smartphone screen
Teacher/Advisor	Student activity monitoring dashboard
	Material Discussion Forum
	Student schedules
	Learning material upload
	Assignments and evaluation
Administrator	User activation and validation settings
	Teacher and student activities monitoring
Parent/School Headmaster	Student learning activities monitoring

Phase 3 Design M-Learning Apps

1. Scenario Design (Use Case)

From solution development in phase two, a mobile learning application development design was prepared. First, the scenario design of this application, which is also the application logic design, is compiled. Figure 2 presents the application logic design that accommodates the needs of each actor described in the previous phase 2.

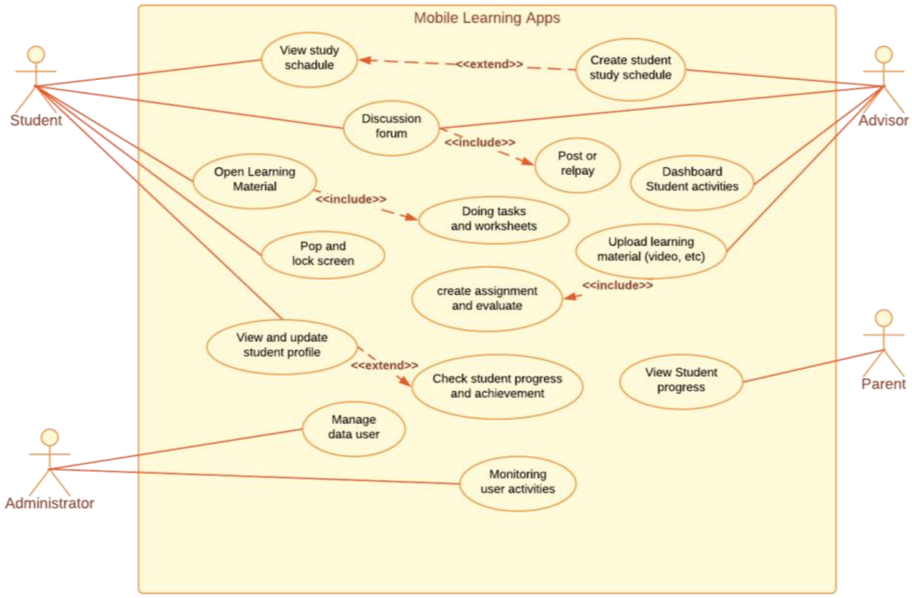

Figure 2. Logical Design for Conjecturing Mobile Learning Apps for Slow Learners

In figure 2, a case shows direct interaction between students and teachers in the discussion forum. In this feature, collaborative learning conditions are possible between students and other students and also with teachers. In addition, in the above design there is a pop and lock screen owned by student actors. This case is only owned by students and runs automatically because it is done from the backend side of the application, thus, it cannot be disabled by students.

2. Database Design

From the scenario above, the data flow that needs to be used to develop mobile learning is identified. Therefore, it is necessary to develop a database design that will be used by mobile learning applications. From the database design presented in figure 3, there are thirteen tables needed for the data flow process. The thirteen tables are the result of third-stage database normalization (3NF), so it can be ascertained that there is no data redundancy [27]. Database normalization is needed to ensure data consistency so that it can produce quality data [28].

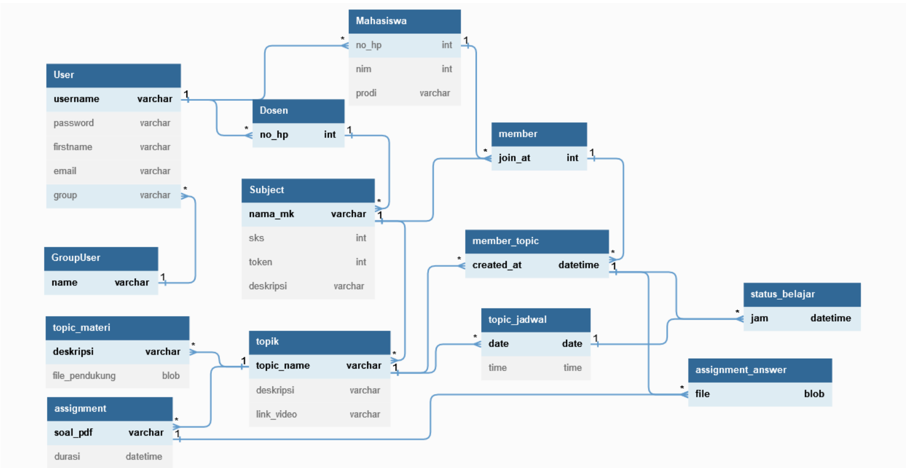

Figure 3. Database Design of Conjecturing Mobile Learning Apps for Slow Learners

3. Software Architecture

After the scenario and design of the data flow or database is known, the software architecture of this application (figure 4) is designed. The software architecture can be assumed as a blueprint of the system to be developed [29].

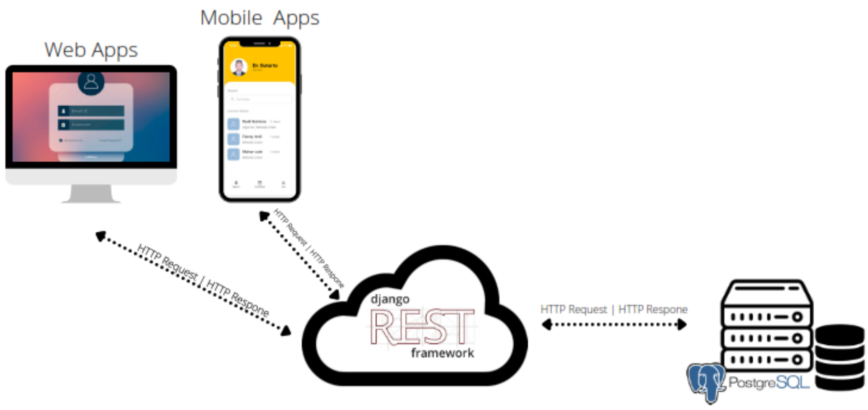

Figure 4. Logical Design for Conjecturing Mobile Learning Apps for Slow Learners

There are several patterns in the software architecture and in the development of this mobile learning microservice architecture is used. In this architectural pattern, the software is formed from several small services that communicate with each other using a simple mechanism [30]. There is a database service that uses PostgreSQL and service logic from the application which is often referred to as a back-end service. In the back-end service, a python-based Django framework is used to handle all logic problems in mobile-learning applications. The back-end service and database service communicate using the HTTP protocol which is managed by the API service using the Django REST framework.

The display to the user is managed in a front-end service that is built using Java Kotlin on the mobile apps side, while on the web apps side it is built using the python Django framework. Communication from the front-end service with other services also occurs through the API using the HTTP protocol.

4. User Interface Design

Figure 5 presents an image of the design of the mobile learning application interface which is a visualization of the previous logic design.

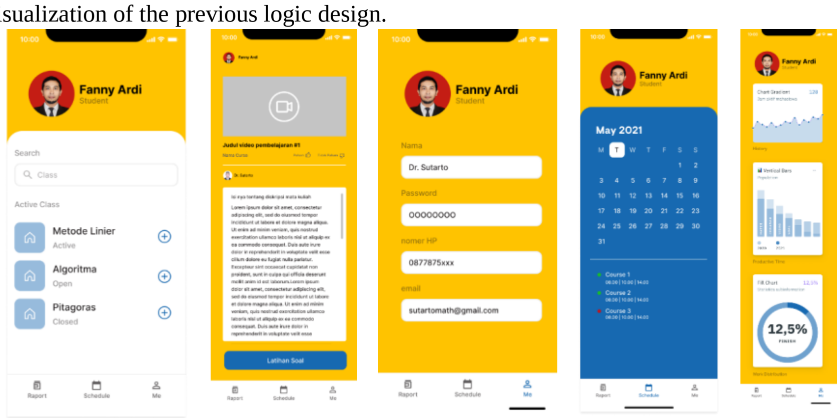

Figure 5. Student User Interface

The first image from figure 3 is a home screen that displays a list of materials being followed by students. This is material that has been determined by the previous teacher through a web-based teacher page. Furthermore, students can access the learning materials that have been set and will go to the page shown in the second image. On the material page, students can access learning materials such as learning videos that can be paused and resumed. This is so that students can easily repeat the learning video if they feel they do not understand the material given. If students feel they understand, they can move on to the next material, but there will be a test in the form of trivia questions that must be answered by students. If the student's answer is correct, then they can move to the next stage, but if not, the student can repeat the material until they successfully answer the trivia question correctly.

Furthermore, students can also select the “Schedule” menu to access the study schedule that has been set by the teacher. If students have carried out the scheduled learning process, the status of learning done or completed will appear. However, if not, a status on schedule will appear, which means that learning has not been carried out. The last menu is the “Me” menu which contains student profiles, as well as student progress and achievement data. This menu visualizes all student learning activities in the form of simple graphs, making it easier to read insights into student development.

Phase 4 Reflections and Documentation

This phase is the final phase of the entire series of phases in this research. In this phase, there are two principles that need to be considered when using the design-based research method

[31]. The first principle is how research findings that are specifically related to innovations or designs produced can improve learning performance and the second principle is that there is a gap to reflect on the performance of research methodologies. Based on the first principle, the design resulting from this research is able to overcome all the problems identified in the first phase. In addition, all processes in phases 2 and 3 needs to be fully and systematically documented so that it is easy to track any changes made. This shows that there is a very important relationship between these two phases.

CONSLUSIONS

The process of designing a mobile learning application in this study focuses on the involvement of stakeholders, especially teachers and slow learners. So there are two phases performed repeatedly (phases 2 and 3) in order to find the application design that best suits the needs of teachers and slow learners. This ultimately resulted in an application design that best suits the user's needs. In addition, all design changes were documented systematically and easily traced. By utilizing this mobile application design, the application development process becomes easier and any limitations that arise at this stage can be identified and minimized more quickly and effectively.

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An assistive technology to enhance conjecturing abilities of slow learners: a mobile application design

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Abstract

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Introduction

One of the standards of reasoning from pre-kindergarten to high school is to create and investigate mathematical conjectures [1]. Making conjectures is important because it serves as a basis for developing new insights and increasing further studies. Creating and investigating conjectures is one of the stages of mathematical discovery [2] and mathematical thinking [3].

A conjecture is a statement about all possible cases based on empirical facts, but with an element of doubt [4],[5]. The process of constructing the conjecture is called conjecturing process [6]. The conjecturing process is carried out through the stages of observing cases, organizing cases, finding and predicting patterns, formulating conjectures, validating conjectures, generalizing conjectures, and justifying generalizations.

Based on the results of the conjecturing ability test in a limited trial at SMP Negeri 19 Mataram, SMP 11 Mataram, MTs Nahdlatul Mujahidin, and SMPN 6 Mataram on number pattern material in 2021 (Applied Research), 45.6% of students did not succeed in constructing conjectures and after further assessment by the Institute for Psychological Consultation and Testing, Mandalika University of Education, 21.5% students were diagnosed as slow learners. The student experienced errors in observing cases, organizing cases, finding and predicting patterns, and formulating conjectures. These errors occur because one of them is a slow learner. In general, slow learner students have lower learning achievements than regular students [7][8][9].

An interview with students revealed the most common obstacles they face: 1) difficulty in understanding abstract concepts; 2) low learning motivation; 3) longer time to understand and 4) the need for repetition in the explanation of the material. The four slow learner students were Generation Z who could not be separated from smartphones and need assistive technology in their learning.

In addition, a number of Sutarto's investigations revealed that many students found it challenging to construct conjecture [4] when attempting to solve mathematical problems [5], [6], and [10]. PBL-based learning tool can help junior high school students' conjecturing skills [2]. Students with special needs may benefit from the usage of assistive technology [11–15]. According to several of these studies, no study was conducted to create assistive technology to enhance the conjecturing skills of students who struggle with learning number patterns.

Assistive technology is a technology that is specifically created to improve the ability of people with special needs to solve problems that they are unable to solve [15]. The use of assistive technology to motivate and have fun with, is carried out in a sustainable manner, facilitates students in independent learning, and helps them to complete assignments.

Based on the problems elaborated, the problem formulation in this research is the development of assistive technology to improve the conjecturing ability of slow learner students on number pattern material. Assistive technology developed is based on a mobile learning application that has popup and lock features, i.e the ability of the application to take over the smartphone screen so that users are forced to complete learning activities as scheduled. In supporting application performance, learning tools including lesson plans, teaching materials, worksheets, evaluation instruments, and video explanations of the material are needed.

The use of mobile learning is proposed in this study because its use is more simple and fun with flexible learning materials [16]. Mobile learning was first introduced in 2005 [17], then it was widely used by researchers to help learning. It has the characteristics of prioritizing ubiquitous (mobility), social interaction, and considering user personalization [18]. Mobile learning is widely defined as a technology-based or techno-centric learning aid [17][19]. The use of mobile learning is able to provide an independent learning experience for students [20].

Methodology

In this study a design-based research model is used as a framework to achieve the research objectives. This model systematically aims to develop solutions to problems faced in the real world [21]. Therefore, this model is used to produce mobile learning applications as a solution to improve the conjecture abilities of slow learners, especially for the number pattern material in mathematics. This model includes four stages: (1) requirement analysis of practical problems, (2) development of solutions to solve problems, (3) m-learning apps design, and (4) reflections and documentations of solutions.

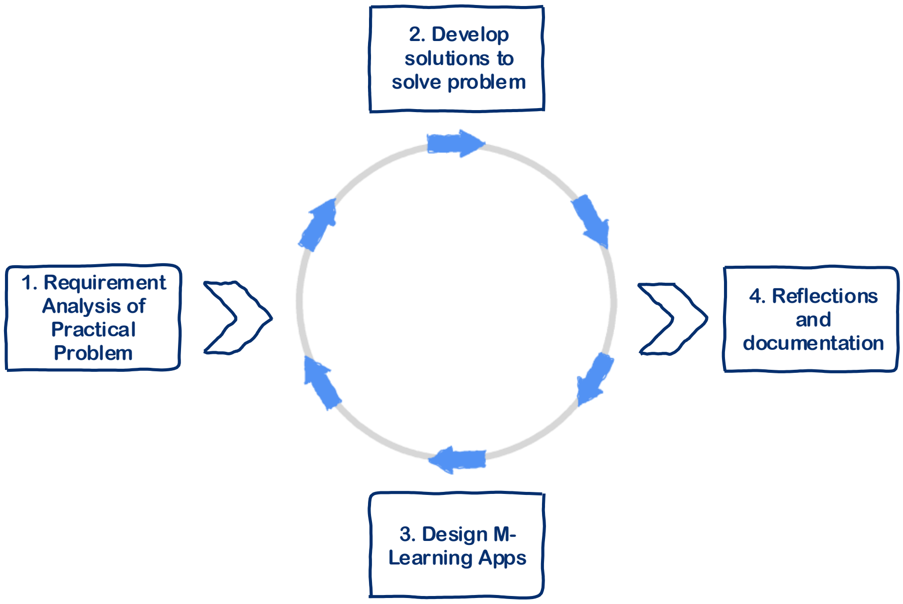

Figure 1. *Design-based research model of this study*

The first phase in this model is requirements of analysis of practical problems. This phase begins by formulating all the problems faced by students and teachers in understanding number pattern material. In figure 1, there are two iterative phases, namely the phase of developing solutions to solve problems and the design phase of m-learning apps. By repeating the third phase, the design of m-learning apps that meet all user needs is expected to be obtained [19]. In this study, iterations in phase 2 and phase 3 were not carried out separately but were repeated together until the m-learning design was in accordance with the specified solution [22]. The last or fourth phase is documenting the m-learning design so that it can be used during the application development process.

Result and disscussion

Phase 1 Requirement Analysis of Practical Problem

The challenge behind the design of mobile learning application is the weak ability of most students in developing their conjecture abilities. Meanwhile, developing a conjecture is one of the stages of mathematical discovery as well as a way of thinking mathematically. A conjecturing ability test showed that 45.6 percent of students at junior high school education level failed in constructing conjectures. After further psychological assessment, it was found that 21.5 percent of students were slow learners. These results were further confirmed by interviews with students indicated as were slow learners. The the main obstacles they faced were difficulties in understanding abstract concepts, low learning motivation, requiring a long and repetitive time in understanding a concept, and indications of addiction to smartphones [23].

This is used as the basis for developing this research. The high tendency of students to use smartphones is also one of the reasons why mobile learning is chosen to help slow learners in addition to the high growth of smartphone users in Indonesia. Hotsuite (we are social): Indonesian Digital Report 2022 released data that there are 370.1 million smartphone users in Indonesia. The use of mobile learning is still a concern for teachers because there is a tendency for students not to use the application. Therefore, it is necessary for the participation of parents to assist teachers in supervising student behavior in using the application. In addition, the application must also be able to directly force students to complete the learning process by using the application. This needs to be considered so that in the application design process it can accommodate the needs of the teachers.

Phase 2 Develop Solution to Solve Problem

Furthermore, based on the analysis of conditions and needs in phase 1, there were several points to be used to develop solutions. The proposed solution must be able to support face-to-face learning activities, improve more effective communication between teachers and students and increase student learning motivation, so that the pedagogic value of mobile learning applications can be felt. There are four basic elements that need to be considered in developing mobile learning applications, namely (1) pedagogics, (2) technology integration, (3) technical assessment, and (4) interactions between teachers and students, as well as interactions between students and students [16].

The development of mobile learning must generate pedagogical elements that are able to accommodate the needs related to blended learning, collaborative learning, and active learning [24], [25]. The solution given to the problem refers to the pedagogic model for mobile learning which is expected to be able to provide skills in Education 4.0 [16]. This model requires technological literacy skills from teachers, students, and even parents [26]. In addition to paying attention to technological literacy skills, mobile learning developed pedagogic values, in particular improving conjecturing abilities in mathematics subjects, especially number pattern material. Therefore, the developed mobile learning must accommodate pedagogic values.

Pedagogic values that need to be integrated into mobile learning are learning conditions, instructional methods, and learning outcomes. In terms of learning conditions, mobile learning applications are required to accommodate learning difficulties faced by slow learners. Meanwhile, in terms of the instructional method, the application is required to provide diverse learning content, especially those that are able to help slow learners in understanding number pattern material. Furthermore, the application must be able to provide various learning strategies for slow learners, such as learning scheduling strategies, as well as learning outcomes evaluation strategies. Eventually, the use of this mobile learning application can meet the learning outcome targets set on the number pattern material.

Utilization of mobile learning as an assistive technology for slow learners should also be able to provide opportunities for students to interact with each other, either through discussion forums or other means such as chat and the like. The teacher acts as a facilitator as well as supervising student discussion activities. Mobile learning applications must be able to provide diverse learning materials such as replayable videos and student worksheets. In addition, the learning material that is built avoids delivering material by requiring students to read for too long because reading material using a smartphone for a long time will make students bored and uncomfortable.

The mobile learning application for slow learners is designed to have the feature of forcing students to learn. This is performed by embedding a feature called popup and lock. This feature allows the application to take over the smartphone layer, so users cannot exit the application before completing the learning process or tasks that have been scheduled by the teacher. With this feature students are forced to complete learning activities as scheduled by the tutor.

In the end, all student activities in using this mobile learning application can be monitored by the teacher through the student performance dashboard feature. The dashboard is able to display all student activities in real time, making it easier for teachers to carry out monitoring and evaluation. Based on the explanation above, there are four actors who use mobile learning with a description of the role of each actor as shown in table 1 below.

Table 1. *Actor and Role Description*

Actor	Role Description
Student	Completing learning activities
Teacher/Advisor	Preparing learning materials, implementing and evaluating learning
Administrator	Managing user management (students and teachers)
Parent/School Headmaster	Monitoring the progress of student learning activities

The four actors above will interact directly with mobile learning application. These four actors each have different needs but are integrated with each other. In table 2, a systematic description of the features of each actor to be developed in mobile learning application is presented.

Table 2. *Features of each user*

User	Feature
Student	Scheduled lessons Material discussion Forum Student worksheets Popup and lock of smartphone screen
Teacher/Advisor	Student activity monitoring dashboard Material Discussion Forum Student schedules Learning material upload Assignments and evaluation
Administrator	User activation and validation settings Teacher and student activities monitoring
Parent/School Headmaster	Student learning activities monitoring

Phase 3 Design M-Learning Apps

1. Scenario Design (Use Case)

From solution development in phase two, a mobile learning application development design was prepared. First, the scenario design of this application, which is also the application logic design, is compiled. Figure 2 presents the application logic design that accommodates the needs of each actor described in the previous phase 2.

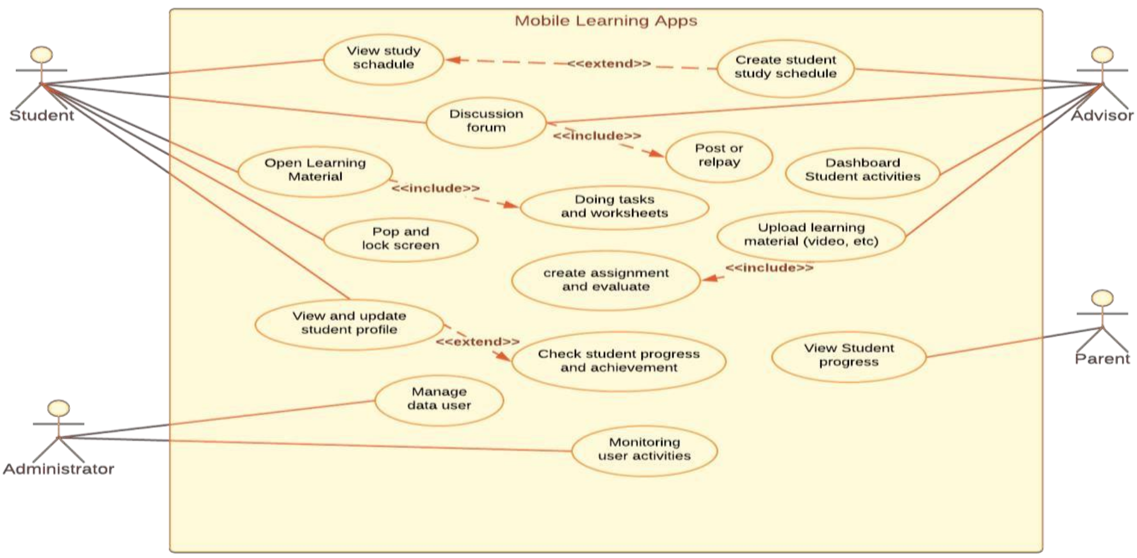

Figure 2. *Logical Design for Conjecturing Mobile Learning Apps for Slow Learners*

In figure 2, a case shows direct interaction between students and teachers in the discussion forum. In this feature, collaborative learning conditions are possible between students and other students and also with teachers. In addition, in the above design there is a pop and lock screen owned by student actors. This case is only owned by students and runs automatically because it is done from the backend side of the application, thus, it cannot be disabled by students.

This feature will automatically be active according to the study schedule that has been set by the previous teacher. This means that every time a student enters the study schedule, the application will give a warning that there is a study schedule that must be completed by the student. Students are given the opportunity to postpone the application to master the smartphone screen three times. This is to anticipate if students are not ready to learn at that time. If students have postponed three times, then there is no tolerance for further delays. This means that the application will immediately dominate the smartphone screen and cannot exit the application until all the scheduled study assignments are fulfilled.

2. Database Design

From the scenario above, the data flow that needs to be used to develop mobile learning is identified. Therefore, it is necessary to develop a database design that will be used by mobile learning applications. From the database design presented in figure 3, there are thirteen tables needed for the data flow process. The thirteen tables are the result of third-stage database normalization (3NF), so it can be ascertained that there is no data redundancy [27]. Database normalization is needed to ensure data consistency so that it can produce quality data [28].

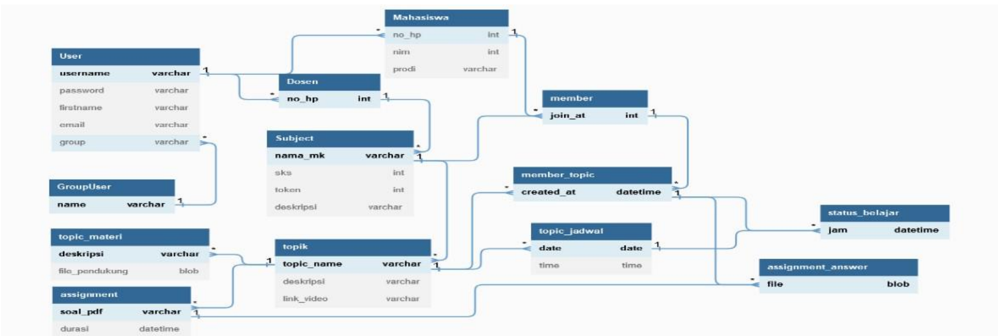

Figure 3. *Database Design of Conjecturing Mobile Learning Apps for Slow Learners*

3. Software Architecture

After the scenario and design of the data flow or database is known, the software architecture of this application (figure 4) is designed. The software architecture can be assumed as a blueprint of the system to be developed [29].

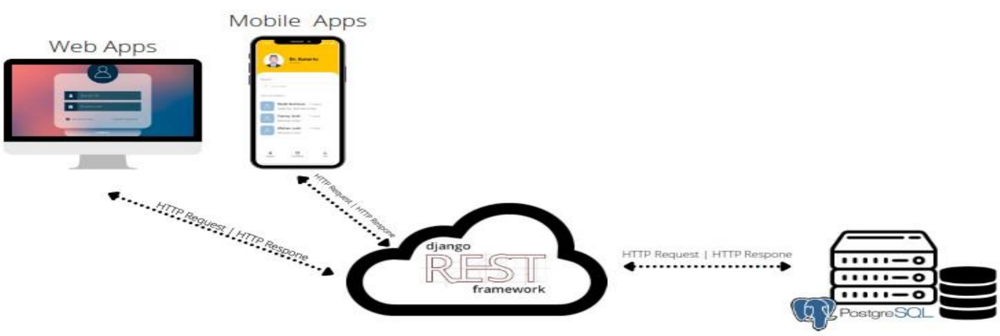

Figure 4. *Logical Design for Conjecturing Mobile Learning Apps for Slow Learners*

There are several patterns in the software architecture and in the development of this mobile learning microservice architecture is used. In this architectural pattern, the software is formed from several small services that communicate with each other using a simple mechanism [30]. There is a database service that uses PostgreSQL and service logic from the application which is often referred to as a back-end service. In the back-end service, a python-based Django framework is used to handle all logic problems in mobile-learning applications. The back-end service and database service communicate using the HTTP protocol which is managed by the API service using the Django REST framework.

The display to the user is managed in a front-end service that is built using Java Kotlin on the mobile apps side, while on the web apps side it is built using the python Django framework. Communication from the front-end service with other services also occurs through the API using the HTTP protocol.

User Interface Design

Figure 5 presents an image of the design of the mobile learning application interface which is a visualization of the previous logic design.

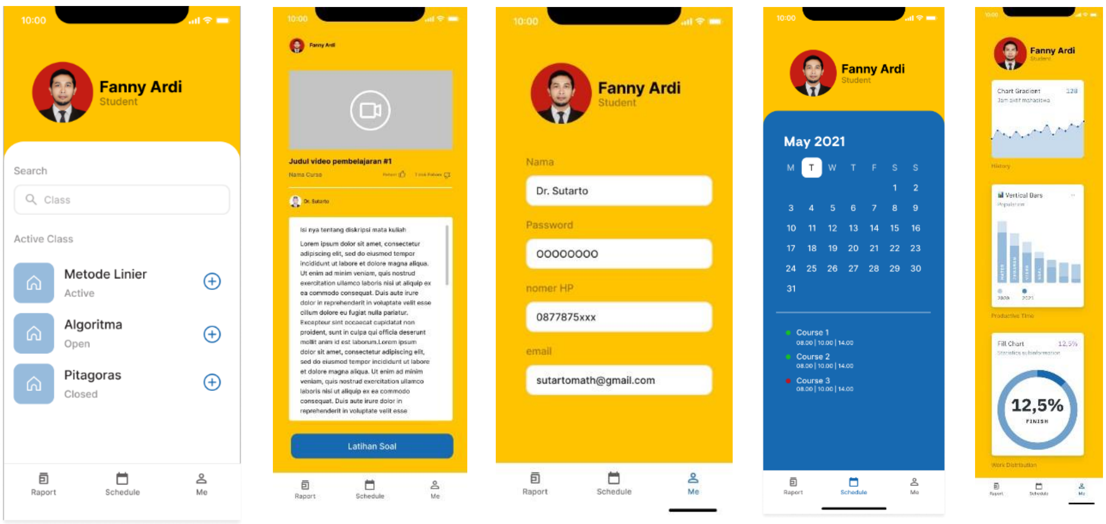

Figure 5. *Student User Interface*

The first image from figure 3 is a home screen that displays a list of materials being followed by students. This is material that has been determined by the previous teacher through a web-based teacher page. Furthermore, students can access the learning materials that have been set and will go to the page shown in the second image. On the material page, students can access learning materials such as learning videos that can be paused and resumed. This is so that students can easily repeat the learning video if they feel they do not understand the material given. If students feel they understand, they can move on to the next material, but there will be a test in the form of trivia questions that must be answered by students. If the student's answer is correct, then they can move to the next stage, but if not, the student can repeat the material until they successfully answer the trivia question correctly.

Furthermore, students can also select the “Schedule” menu to access the study schedule that has been set by the teacher. If students have carried out the scheduled learning process, the status of learning done or completed will appear. However, if not, a status on schedule will appear, which means that learning has not been carried out. The last menu is the “Me” menu which contains student profiles, as well as student progress and achievement data. This menu visualizes all student learning activities in the form of simple graphs, making it easier to read insights into student development.

Phase 4 Reflections and Documentation

This phase is the final phase of the entire series of phases in this research. In this phase, there are two principles that need to be considered when using the design-based research method [31]. The first principle is how research findings that are specifically related to innovations or designs produced can improve learning performance and the second principle is that there is a gap to reflect on the performance of research methodologies. Based on the first principle, the design resulting from this research is able to overcome all the problems identified in the first phase. In addition, all processes in phases 2 and 3 needs to be fully and systematically documented so that it is easy to track any changes made. This shows that there is a very important relationship between these two phases.

Conslusions

The process of designing a mobile learning application in this study focuses on the involvement of stakeholders, especially teachers and slow learners. So there are two phases performed repeatedly (phases 2 and 3) in order to find the application design that best suits the needs of teachers and slow learners. This ultimately resulted in an application design that best suits the user's needs. In addition, all design changes were documented systematically and easily traced. By utilizing this mobile application design, the application development process becomes easier and any limitations that arise at this stage can be identified and minimized more quickly and effectively.

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