Development of Game-based Learning using A Mobile App for Students Fractions Learning

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Abstract. Fractions are quite difficult lessons. Therefore, in elementary school, third-grade students have been taught how to solve fractions problems. Various innovations developed to make fractions learning easier for students. One of the uses of technology for efficient learning that can be carried everywhere is a mobile. The use of mobile for learning provides good ideas and benefits to motivate students in the learning process. In this study, the researcher develops a mobile app called Pecahanku to help students learn fractions. Black-box testing and TAM are used to measure eligibility and users’ acceptance toward using the mobile app. Pecahanku mobile app consists of a representation of fraction and fraction operation. Pecahanku mobile app also supports authentic learning to improve students’ understanding. The result shows that Pecahanku mobile app is eligible for use by students. Moreover, students perceive that using this mobile app for their learning process is easy to use. Thus, Pecahanku mobile app can make students feel fun and enjoy when students learn fractions.

1. Introduction
Daily-life is inseparable from fraction math. However, fractions are quite difficult lessons [1]. Therefore, in elementary school, third-grade students have been taught how to solve fractions problems. Various innovations developed to make fractions learning easier for students. For example, a teacher in Jogja, she uses a circle or square image media to illustrate fractions. A teacher in Tasikmalaya Elementary School used folding paper for learning fractions [1]. So, it is possible to make some learning innovations using technology. One of the uses of technology that can make learning more efficient is a mobile phone because it can be taken anywhere [2].

The use of mobile phones for learning provides good ideas and benefits to motivate students in the learning process [3] [4]. Thus, by using mobile learning for fractions becomes an innovation to help students to learn fractions. This innovation can expand students’ understanding of fractions [1]. Therefore, it is necessary to develop a mobile application (mobile app) to realize mobile learning.

In this study, the researcher develops a mobile app called Pecahanku to help students to learn fractions using ADDIE and Waterfall Model [5] [6] [7]. This mobile app consists of a representation of fraction and fraction operation. Pecahanku mobile app also supports authentic learning to improve students’ understanding. Authentic learning can help students to relate fraction problems with the real-world [8]. Authentic learning gives real imagination of problems that can make students active in learning [9]. Active students will gain learning goals easily. A mobile app with authentic learning combined with game-based learning can help students more active learning [10]. Game-based learning is combining knowledge into games, thus make students feel they play games when they learn with game-based learning [11] [12] [13]. A game can use for learning if it has four features: goal, rules,
feedback, and voluntary participation (agree with goals, rules, and feedbacks) [12]. This mobile app developed to help students to learn fractions more active, fun, and memorable to improve their learning process [14] [15].

Black-box testing is used to measure eligibility for this mobile app using percentages [16]. TAM is used to measure users’ acceptance of this mobile app [17]. Based on the explanation, the question in this study is how the eligibility of this mobile app and how the acceptance by using this mobile app ‘Pecahanku’ for students learning fractions.

2. Research Method
In this study, participants are 23 teachers and students at Elementary School in Surakarta, Indonesia. Also, three experts for testing this mobile app. Researchers collect the data during COVID-19. Fraction mobile app developed to help teachers teach students during COVID-19 because teachers cannot meet students face-to-face.

2.1 Fraction in Learning
Learning material in this study was designed in three topics: fraction representation, addition, and subtraction. The first topic is fractions representation. Fractions representation allows students to make a representation image of fractions using take pictures. Students make fraction representation with drawing fractions on the image. Then, the second topic is addition fractions operation. The last topic is subtraction fractions operation. Moreover, several exercises containing fraction questions can be accessed by students online.

Learning material was developed with the ADDIE Model: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation. ADDIE architecture is shown in Figure 1. First, an analysis uses to determine fractions learning requirements. Then, design fractions learning based on the analysis. In the development stage, the researcher will develop a mobile app ‘Pecahanku’ using a waterfall model combine with fractions learning for the learning material. Last, implement the mobile app for students learning then do an evaluation.

![Figure 1. ADDIE Architecture](image)

2.2 Mobile App: Pecahanku
A mobile app, Pecahanku will develop using the waterfall model by Pressman: (1) Requirement Analysis, (2) Design, (3) Code, and (4) Testing. The architecture is shown in Figure 2. Requirement analysis uses to determine user requirements for mobile apps. After that, Design a mobile app based on requirement analysis (Fig. 3). After finish designing a mobile app, develop a mobile app using Android Java Language. The three main features in this mobile app: take pictures, drawing images, use the internet for access fraction practices, and feedback. Lastly is testing the application. Testing done with two stages are the black-box testing and Technology Acceptance Model (TAM).
Figure 2. System Architecture

Figure 3. (a) Menu Design, (b) Make Fraction Symbol to Image, and (c) Fraction Operation in Addition

Black-box testing uses five-scales Likert. Five-scales Likert consists strongly agree, agree, neutral, disagree, and strongly disagree. Then score from five-scales Likert changed to percentages. The researcher changed the total scores into percentages to make five-category. Five categories are very good, good, neutral, bad, and very bad.

TAM consists of four dimensions: Perceived Ease of Use (PEU), Perceived Usefulness (PU), Attitude Toward Using (ATU), and Behavior Intention of Use (BIU). However, the researcher modifies TAM by adding one dimension as needed. The new dimension is perceived playfulness (PP). PEU dimension uses to measure users’ perceptions of easy to use. PEU dimension makes users have playfulness toward using this mobile app. However, users’ perceptions of easy to use also make users think the usefulness (PU) of this mobile app. PEU, PU, and PP dimensions make users have an attitude toward using this mobile app. Users’ attitudes toward using this mobile app ‘Pecahanku’ influence
users’ tendency (BIU) to use it. So, the relationship between TAM dimensions builds users’ acceptance. For measuring TAM, researchers using Cronbach’s Alpha and Frequencies.

3. Result and Discussion

3.1. Students Submission
Data collection shows several submissions from students. In the first activity, students make fraction representation using drawing fractions on the pictures (Fig. 4). Then, students did fractions operation (addition and subtraction). The last students did fraction practices that consist of fraction questions.

![Figure 4. Drawing Fraction Representation](image)

3.2. Black-box testing
In this study, black-box testing uses to measure the functionality of this mobile app. The functionality dimension of this mobile app has several specifications. The specifications of this mobile app are shown in Table 1.

| Specification                        | Mean | Percentage (%) | Category     |
|--------------------------------------|------|----------------|--------------|
| Functionality                        |      |                |              |
| Login                                | 5    | 100            | Very Good    |
| Menu button                          | 5    | 100            | Very Good    |
| Scroll direction view                | 3.7  | 73             | Good         |
| Take picture                         | 3.7  | 73             | Good         |
| Drawing image                        | 4.7  | 93             | Very Good    |
| Notification empty input             | 4.7  | 93             | Very Good    |
| Notification incorrect answer        | 5    | 100            | Very Good    |
| Notification correct answer          | 5    | 100            | Very Good    |
| Answer check                         | 5    | 100            | Very Good    |
| Scoreboard                           | 5    | 100            | Very Good    |
| Feedback (Incorrect)                 | 5    | 100            | Very Good    |
| Feedback (Correct)                   | 5    | 100            | Very Good    |
| Retry to answer (When feedback incorrect) | 5    | 100            | Very Good    |
| Save an image                        | 5    | 100            | Very Good    |
| Internet Access                      | 5    | 100            | Very Good    |
| Permission to Storage                | 5    | 100            | Very Good    |
Black-box testing of this mobile app indicates that the functionality of this mobile app in the good to very good range. For login, menu button, notification incorrect answer, notification correct answer, answer check, scoreboard, feedback (incorrect/correct), retry to answer, save an image, internet access, and permission to storage get a mean score of 5. Drawing image and notification empty input specifications get a mean score of 4.7. Then, scroll direction view and take picture specifications have a mean score of 3.7.

3.3. Technology Acceptance Model
In this section is to explain the data analysis. The analysis consists of the reliability of TAM Dimensions and Descriptive Frequencies of the TAM dimension.

3.3.1. Reliability of TAM Dimensions
TAM questionnaires have a reliability value of 0.864 with 18 questionnaires. It indicates that the questionnaires can use to evaluate the TAM of the mobile app. Moreover, each dimension has reliability >0.60 and is shown in Table 2. It indicates that TAM has reliable dimensions. Reliable dimensions can use to measure the next step.

| Dimensions | Reliability | N |
|------------|-------------|---|
| PEU        | .757        | 4 |
| PU         | .777        | 3 |
| BIU        | .737        | 5 |
| ATU        | .670        | 4 |
| PP         | .784        | 2 |

3.3.2. Descriptive Frequencies of TAM Dimension
Table 3 shows that the PEU dimension has a lower mean than the other dimensions (M=4.326, SD=.576). PEU result indicates that users perceive using this mobile app is easy to use. ATU dimension gets high mean after PEU dimension (M=4.337, SD=.598). ATU dimension result indicates that participants can accept the mobile app to help students learn fractions. Moreover, the PP dimension result shows that this mobile app makes students feel fun and enjoy (M=4.391, SD=.537). PU dimension result shows that students who use this mobile app can get fraction learning experience (M=4.420, SD=.553). The fraction learning experience can help students improve their learning process. The last dimension is the BIU dimension. BIU dimension has a higher mean than the other dimension (M=4.426, SD=.578). BIU dimension indicates that students will use this mobile app to help their learning process.

| PEU | PU | BIU | ATU | PP |
|-----|----|-----|-----|----|
| 4.326 | 4.420 | 4.426 | 4.337 | 4.391 |
| .576  | .553  | .578  | .598  | .537  |
| 3     | 3     | 3     | 3     | 3     |
| 5     | 5     | 5     | 5     | 5     |
| 4     | 4     | 4     | 4     | 4     |

4. Conclusion
Based on the result, we can conclude two conclusions: eligibility of this mobile app and TAM result toward using this mobile app. In the first conclusion, game-based learning using Pecahanku mobile app for students’ learning can work well. So, teachers can use this mobile app to help students to learn fractions. In the second conclusion, game-based learning using the mobile app ‘Pecahanku’ for
students’ learning makes students feel fun and enjoy. Students thought that using this mobile app is like learning with playing games. Moreover, students perceive that using this mobile app is easy to use for their learning. Thus, students will get experience in their fraction learning process when they feel fun and enjoy when they learn using Pecahanku mobile app.

This study only measures the eligibility and users’ acceptance of this mobile app. Researchers did not measure students’ achievement toward using this mobile app. Researchers conducted this study during pandemic COVID-19. Students use this mobile app to learn fractions from their homes. For future studies, researchers will measure students’ learning achievement toward using this mobile app with more participants, make students submission can send to the teacher automatically, and make the question in this mobile app can change by the teacher.

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