Learning device in the “STEMpedia” mobile learning application

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Abstract. Access to the results of the audience and the use of innovative mobile learning with the aim of innovation, skills in technology, and media information are indispensable. The implementation of science, technology, engineering and mathematics (STEM) learning as innovative learning in elementary school must be accessible to the teacher in real life. STEMpedia's mobile learning application was developed using Design-Based Research model Reeves, which consists of four stages: 1) identification and analysis of the problem; 2) Development of solutions based on information obtained; 3) Perform repeated processes to test and repair; 4) Reflections. The results of this research in the form of mobile learning application in STEM learning in elementary school that contains learning device and video of STEM learning implementation, this mobile learning application can be accessed on Android smartphone version. The product is accessed by the teacher as a medium to learn STEM learning so that the real picture of the condition in its implementation.

1. Introduction
As the time goes by and technological advances develop, education needs to go along with this change. Teachers are the main key in improving education quality, so they must be able to follow the era and take the advantages of the technological developments [1]. Therefore, the more developed science and technology, the more effort needed to ease the access of science developments [2]. Thus, the opportunity created by the presence of technology among people needs to be used by teachers to be more technologically literate in improving the learning process. Nowadays, a variety of sophisticated tools can be used to meet daily needs, including the use of smartphones. A survey indicated that 2 out of 3 people in Indonesia had a cell phone [3].

Ideally, the learning model reference should be easily accessed by the teacher. However, in reality, these references were not widely available [4]. Although various kinds of online learning products have emerged currently, they are only available for students to strengthen their knowledge on the learning material [5] which is different from the teachers’ needs. There are limited references of learning models for teachers which could be used to learn and improve their quality [6]. Even though internet provides various videos of teachers teaching in the class [7], the videos are only limited to documentation, which shows the teacher's activities in class without any explanation of every step done. This resulted on teacher watching videos without being able to master the skills in implementing the learning model presented in the video.

Similar thing happened to the teaching administrations reference. Many websites on the internet provide ready to use lesson plans [8] without other supporting teaching administrations. No one
provides teaching administrations, such as worksheets, modules, media, or comprehensive assessments. Thus, the teachers have to make it themselves. This is inefficient to make teaching administrations from the beginning and it must be relevant with the teaching steps in the lesson plan. Even though there are many examples of teaching administrations such as lesson plan available on the internet, they are not followed by the instructions to use them. Thus, the objectives of the lesson cannot be seen clearly. In consequence, a complete teaching administration including the instructions on how to use it is needed to help teachers learn innovative teaching implementation.

STEM learning is one of the innovative learning developments by integrating four branches of science into a cohesive and active learning approach [9]. It stands for Science, Technology, Engineering, and Mathematics. Science can be defined as a study of concepts and laws in the environment while technology is defined as a skill and a means to meet human needs in completing their job. Further, Engineering is the skill to perform or design a strategy to solve problems and Mathematics is a branch of science that studies the relationships among numbers, quantities, and shapes through logical argumentation [10]. The application of STEM in learning can prepare students to face the new challenges in the future due to technological developments [11]. Moreover, STEM can serve as a way to cultivate new competencies in students such as problem-solving competencies and the skills to carry out experiments [12]. To apply the learning model and achieve the objectives of the learning, teachers must prepare themselves first to study the learning model. Therefore, in studying a learning model it is important to know the teaching administrations used [13]. STEM teaching administrations include lesson plan (Rencana Pelaksanaan Pembelajaran), student worksheets, learning modules, media, evaluation and performance assessment rubric. The learning media in this model has a substantial role because they are the products of the problem-solving project. Therefore, teachers must learn how to use the media in STEM learning. In its implementation in the class, the media will be designed by students assisted by the teacher. The teacher has to guide the students in designing the media product and finalize its form. Thus, a complete reference for teaching using STEM learning model, including the teaching administrations, is necessary for teachers.

Based on the explanation aforementioned before, it is necessary to develop a new innovation to improve the quality of teachers in teaching. The development of this application can be a reference for teachers to study STEM learning model in the form of mobile-learning application which is in contrast to the other studies that develop applications for students to use in learning.

2. Methods
The development of this product was carried out using design-based research (DBR) method adopted from Reeves [14] qualitatively (Figure 1).

![Figure 1. Design-based research steps.](image-url)

Problem identification and analysis was performed by reviewing the literatures, searching videos on the internet and conducting interviews with six elementary school teachers in Indonesia. This stage was carried out to acquire references about the product to be developed. The result of this study was then reflected by colleagues who concerned about applications development and learning in elementary schools. After obtaining product development reference, a mobile application was developed using Draco Kodular software. The application development could not be separated from
the programming language such as source code block to code. In addition, other application such as Corel Draw X7 and Wondershare Filmora were used to process images, videos and also sound.

A pilot testing of the mobile application product was carried out in two cycles as a means of evaluating the product to fix the problem so it can meet the intended use and relevant for the users by interviewing them. The teachers and prospective teachers were selected to be the respondents since the application was intended as alternative source for STEM-based learning in elementary schools. The product reflection was done by reviewing all the stages carried out and summarizing the overall results of the data obtained in the field for evaluation. Thus, the final result was an application that could provide benefits to both users and developers. Lastly, the data analysis carried out included data collection, data reduction, data presentation, and conclusions (description / product verification) [15].

3. Results and discussion

3.1. The analysis of the problem
The lack of media to become the reference for learning activities had demanded us to take serious action. The references available could not support the implementation of learning activities in the classroom. They were only guidebooks which limited teachers to develop teaching and learning process in the classroom. Moreover, the use of cell phones that closely related to everyday life is growing and almost all teachers have cell phones, categorized as smartphones, which can be used as a reference for teaching [16,17].

3.2. Mobile-application design for STEM-based learning in elementary school
The development of learning media applications operated an electronic control system carried out using waterfall software development model which consists of 4 stages, namely (1) software requirements, (2) design, (3) code generation and (4) testing [18]. The development of this application design put its concern on the scope of teaching material in elementary school curriculum, the display design, the ease of application use, and the use of programming applications to be used. The initial validation process was done by inviting colleagues in elementary school learning development, application development, and learning video development. In addition, expert validation was conducted to acquire suggestions for conceptual product improvements [19]. The result of these validation was related to content and STEM-based learning focus, graphic aspects in the menu containing content, and the design of video to be uploaded which need to consider the pictures relevant with the students and teacher’s activity during the learning process. The result of this validation was also expected to meet the six usability criteria, namely effectiveness, efficiency, safety, utility, learnability and memorability. Thus, the system in the application can be Effective to use, Efficient to use, Safe to use, Has good utility, Easy to learn and Easy to remember the way to use [20].

3.3. Mobile application field trial
The trial resulted on some further suggestions regarding the improvements to the mobile application. The improvements included the overall appearance of the application, application content, audio, video and text, and the operation of the mobile application.

3.4. STEMpedia mobile learning application description
Users can download this mobile application for free with less than 10 Mega Bite so that it doesn't bother user's storage. The result of writing the application code in the .AIA format was changed to an .apk extension so that it can be installed on mobile devices based on Android 7.0 and above. In order to run the application properly, the mobile phone must have at least 7.0 Nougat Android system. The application is labelled as STEMpedia so that it represents the content. Furthermore, a description was added to show the creator of the application. After a series of trial was completed, the application was published on Google's digital content service or Google Play Store in the form of an .apk extension
which size is less than 10 MB. The QR Code to access the mobile video application for the implementation of STEM learning in elementary schools can be seen in the following Figure.

![QR Code](image1)

**Figure 2.** QR code of STEMpedia mobile application.

![STEMpedia App](image2)

**Figure 3.** STEMpedia application installed in a mobile phone.

The final result of STEMpedia development is in the form of a mobile application that can be used as a reference for teachers and prospective teachers in designing a lesson. There are several advantages and disadvantages of using this application compared to the other types of learning references. The advantages of this application are described below.

- The application provides complete information about understanding learning technics by providing a menu of teaching administrations on the content, namely learning module on the related themes and sub-themes, lesson plans, user manual of the media, student worksheets relevant with the lesson plan, HOTS questions to complement the learning evaluation and performance assessment.
- This application is practical in use and easy to install on devices running Android system version 7.0 Nougat and above.
- The user interface is simple which makes users will easily remember the application use so that it is useful for long-term.
- The developed products can be used as a reference for teachers and prospective teachers in determining learning designs and an overview of its implementation in video form.
- The application was designed by considering its usability or user friendly, displaying attractive colours and adding back sound to add up the application attractiveness.

On the other hand, the drawbacks of this application are listed below.
The product can only run-on devices based on Android 7.0 Nougat and above. The application often crashes or forced to close which make it stops automatically in Android 6.0 version Marshmallow and below.

Researchers cannot predict the loading speed of pages stored on each content as it depends on the internet speed of the device used.

The application needs cellular data or Wi-Fi connection to run so unavailability of internet connection will not display the application.

The application currently developed is still limited to one material only so that it cannot display STEM-based learning content on the other themes.

The android-based mobile learning application was developed as a reference for teachers to learn learning models and acquire teaching administrations. Android-based mobile applications could be used to facilitate independent learning process that did not depend on a tutor since the application already provided material available at any time without opening any printed book [21]. Moreover, learning something new by using mobile devices gave opportunities for everyone by providing accessible learning in different places [22]. Learning through applications could be claimed as a systematic and dynamic learning environment with the use of technology in education [23].

The STEMpedia application can be used as a reference for implementing STEM-based learning by elementary school teachers. The use of Information and Communication Technology (ICT) in STEMpedia application makes it easier for teachers to use. ICT can remove the boundaries of space, time and places [24] with ease and low cost. The use of smart phones as a tool to open learning applications also improved the quality of teachers in making good use of Information Technology [25]. Moreover, Information Technology make it easier for teachers to find sources for learning [26]. Considering the efficiency of using the STEMpedia application, learning activities for the STEM-based learning model which is a new learning model for teachers will not be a problem because it is equipped with the required learning tools.

To help teachers learning each teaching administration, the application is equipped with a user guide video. The video is considered effective for learning something [27]. The activity of seeing and listening to video has the most senses included during process compared to the other media [28]. The videos contained in the STEMpedia mobile learning application are videos about every teaching administration, the way to use the teaching administration, and the conditions suitable for using the teaching administrations.

The implication of using STEMpedia application is the innovation resulted to improve the quality of teachers in mastering the STEM learning model in elementary school level. The use of STEM-based learning model by teachers can foster students' higher order thinking skills [29-31]. The learning activities and students’ interests had a major effect on students’ learning success [32]. Therefore, the STEM-based mobile learning application does not only accommodate a good impact on improving the teachers’ quality, but also on the success of students in implementing learning at school.

4. Conclusions

The need for teachers to improve their learning process can be done by studying various innovative lessons to be implemented in class. This innovative mobile learning application addressed as STEMpedia was designed to meet this teachers’ need. This application is functioned as a reference for the development and implementation of learning models and STEM-based teaching administration provider. To assist teachers mastering STEM-based learning model, they need to be equipped by teaching administration and its instruction. Thus, the STEM-based learning and its implementation were made in an Android-based application by utilizing the advance of technology so that teachers can easily access it. This application is expected to be used by teachers to implement STEM-based learning in school.
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