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# Designing Android based Mobile Application for Earth Layer Learning at Junior High School

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ABSTRACT

The complexity of science topics makes it difficult for students to understand all science concepts correctly. Mobile devices can help students to be more focused and efficient in learning. The study aimed to develop the android - based mobile application about the earth layer and include its natural disaster concept. The development model used was the 4D Model. This research produces a product in the form of Earth Panel Cellular Application. The expert validation average score of 3.38, which is in the excellent category, shows that the earth layer application is suitable for usage. The application's effectiveness can be quite effective in enhancing students' cognitive learning outcomes based on the gained sig. The significance of application is said to be quite effective in improving cognitive learning outcomes with a value of 0.000 less than 0.05.



## I. Introduction

Science topics are typically comprised of certain concepts, and their intricacy has made it difficult for students to properly understand all of the Science concepts (Nazar et al., 2022), including the concepts of the structure and layers of the earth. The enormous number of definitions and phrases used by both teachers and Science textbooks contribute to some of the difficulties students have in grasping the idea of earth layer (Rokayah & Rochman, 2021). Furthermore, the many concepts that must be learned by students such as the characteristics of each layer of the atmosphere, lithosphere and hydrosphere, make it difficult for students to understand (Basuki & Sudibyo, 2021). Such concepts are abstract and difficult to describe by students, so they tend to lead to misconception (Nisa et al., 2022; Yanmesli, 2018). As a result, in today's classrooms, a unique method and modern learning resources are essential and required.

Students must learn essential terms and the characteristics such as the crust, mantle, outer core, earth's atmosphere layer (i.e., troposphere, stratosphere, mesosphere, thermosphere, and exosphere), hydrosphere, and the types of natural disasters that occur on earth, to understand the concept of earth layer better. These ideas are somewhat abstract, making them difficult for students to understand (Isty et al., 2021). As a result, technological approaches such as mobile learning hold a lot of promise to assist them in learning more effectively. Students who learn on a mobile device are not only more engaged in the subject matter because they enjoy using the device (Sunarya et al., 2020), but they are also better able to maintain a schedule and location for learning because mobile learning is flexible and convenient (Sitompul, 2018). By definition, mobile learning is learning that takes place anywhere and at any time using mobile devices such as smartphones, tablets, and other similar devices (Crompton et al., 2016).

The growing use of smartphones in the classroom has pushed the adoption of tools such as learning media. To obtain maximum results, more and more teachers in colleges and schools are integrating the usage of mobile devices in the classroom to encourage more innovative learning (Naciri et al., 2020). Students who use mobile devices in class believe that using them in class can help them be more focused and efficient in their studying (Huang et al., 2016). According to studies by Macaluso & Hughes, (2016), students who use mobile applications in their learning achieve better grades than students who simply learn to use textbooks.

Android is a mobile operating system based on a Linux kernel that has been customized (Novaliendry et al., 2021). Teachers can use the Android platform to combine various forms of material, such as image, text, graphic, audio visual, and interactive videos content, to activate numerous

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student recognitions (Untari et al., 2021). Despite the abundance of Android apps about science made by the community and programmers available on Google Play, only a few apps were built for academic reasons (Nazar et al., 2022). The apps were not adequately designed for learning, and so did not fit the criteria for proper learning materials; and the majority of them were created without doing a need analysis. Crompton et al., (2016) explained that the most research on mobile learning in science focused on the life science concept by 67 % and only 6 % concerned on the earth science concept. In addition, research by Sunarya et al., (2020) developing 'E-Layer' android mobile application has nevertheless identified the limitation of the app in the term of the content, namely unavailability of natural disaster sub-topic.

Therefore, this study aimed to develop the android based mobile application about earth layer and including it natural disaster concept. This application is expected to facilitate students in independent learning. Independent learning abilities are critical for students in this digital era.

## II. Method

### *A. Research Design and Procedures*

The application of the earth layer was created using R&D (research and development) method by adopting 4D model by Thiagarajan, (1974). This study was worked on two stages: first, Earth Layer android mobile application development, and second, a quasi-experimental stage to evaluate the earth layer application effectiveness. The first stage used the four-D model (4D model) consisting of four stages of Define, Design, Develop, and Disseminate. However, this study involved only three of the four stages of the 4D model, since the developed application was not distributed to other schools, which means that the fourth stage is not per-formed. A brief development description of the application can be explained as follows: (1) de-fine; this stage is to define the instructional requirements, such as analyzing the instructional problems, identifying the learner needs, analyzing the concepts, and formulating the learning objectives; (2) design; the purpose of this stage is to design prototype of earth layer android mobile application that consisting of four learning meetings and covering four sub-topic of earth layers, such as atmosphere, lithosphere, hydro-sphere, and natural disaster. (3) development; the developmental stage is aimed modifying the prototype of the application that was designed in the design stage. There are two steps in the development stage, namely expert appraisal or validation aimed to obtain suggestions for the improvement of the application and field testing purposed to examine the effectiveness of the application.

The developed application modified and considered valid was tried out to students. The tryout was conducted to obtain suggestions directly from the location. A tryout was per-formed on 23 seventh - grade students at one of the public junior high schools in Sidoarjo. The tryout was conducted by adopting the one-group pre-test post-test design, (Fraenkel et al., 2004). A diagram of this study design is in the Table 1.

Table 1. One-group pretest-posttest design experiment

| | | |
|---|---|---|
| O1 | X | O2 |

### *B. Instruments*

Questionnaires and cognitive learning out-comes tests were utilized as instruments in this study. The validation questionnaire was used to assess the display, language, and image/graphic presentation of the application. This instrument was used to collect information about validators' evaluations and suggestions for the earth layer android mobile application. Construct validation, exactness, completeness, and suitability are all included in validation. In addition to the questionnaire, the tests were used to assess the students' cognitive learning outcomes con-structed based on the learning objectives of the earth layer concepts. The grid of the test instrument was shown in Table 2.

Table 2. The Grid of Cognitive Learning Outcome Test

| Learning Objectives | Item Number |
|---|---|
| Explaining the concept of the earth layer including the atmosphere, lithosphere, and hydrosphere. | 1,2,3,4,5,6,7,8, 9,10,11,12,13 |
| Explaining the volcanic natural disasters | 14, 15 |
| Explaining the earthquake disaster | 16, 17 |
| Explaining the disaster response action | 18, 19, 20 |

### *C. Data Analysis*

The data of the validation results of the earth layer android mobile application and cognitive learning outcomes test are analyzed descriptively and inferentially. The gained average scores of the application and learning outcome test from the validator then are described regard-ing criteria shown in Table 3. Moreover, the da-ta of the learning outcomes test was analyzed inferentially using a t-test to know the effectiveness of the application. If the sign value is more than 0.05, then H0 is accepted. In other words, the Earth Layer android mobile application has a significant effect on cognitive learning outcomes.

Table 3. Criteria of Validation Results

| Score Interval | Category and means |
|---|---|
| $1{,}0 \leq VS \leq 1{,}5$ | "poor": it is not useable |
| $1{,}6 \leq VS \leq 2{,}5$ | "fair": Useable with many modifications |
| $2{,}6 \leq VS \leq 3{,}5$ | "good": Useable with slight modification |
| $3{,}6 \leq VS \leq 4{,}0$ | "excellent": Useable without modification. |

## III. Results and Discussion

The android application development process follows the 4D development model, namely define, design, and development which is described in detail as follows:

### A. *Define*

This phase is mainly analytical. The four steps of this stage are front-end, learner, task, and instructional analysis. The front-end analysis has relied upon the challenges of learning during the COVID-19 pandemic and future, in which teachers are required to carry out adaptive learning. Therefore, it is needed learning media that can help teachers in conducting either online or offline learning. One of the media that can facilitate students in learning with two learning conditions is the use of android applications. In the learner analysis, seventh grade students are between 15-16 years of age which according to Piaget's theory, they are assumed to be in formal operational stage of development. In the early stages of development, children tend to think exceptionally concretely and explicitly, and they begin to examine various outcomes and repercussions of activities. Because of the transition from the concrete to abstract, students need a learning media that can visualize abstract science concepts. Task analysis is the identifying of the main skill to be ac-quired by the students and analyzing it into a set of necessary and sufficient sub skills. The coverage of the task in this study is based on the national curriculum, namely 2013 curriculum. Regarding to the topic that was chosen in this study, Earth Layer, the basic competence in the curriculum is 3.10 to describe the layers of the earth, volcanoes, earthquakes, and risk reduction actions before, during, and post-disaster according to the threat of disaster in the area. Moreover, the instructional analysis is the identifying of the major concepts to be taught, arranging them in hierarchies, and breaking down individual concepts into critical and irrelevant attributes. The concept analysis of this study is shown in Figure 1.

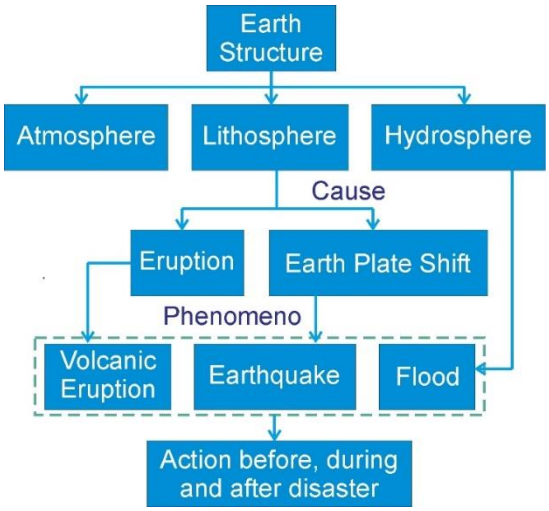


Fig. 1. Concept Analysis of Earth Layer

### B. *Design*

The design stage was completed to create an android mobile application for earth layer. It began by using visuals, texts, animations, audio, and videos to design the success of students' learning outcomes. The design process of the earth layer application began with the creation of an application icon and picture in CorelDraw. The next stage is to utilize Adobe Flash to develop an interface, which includes producing icons and moving animation. The processes of planning and generating content for coding instructional games are depicted in Figure 2. This was the most challenging portion since the photos, objects, messages, audio, moves, and backgrounds must be put one by one, and it is needed creative skills to create moving animations and interactive buttons.

**Source code :**

Ke_menu

```
b_menu.addEventListener(MouseEvent.CLICK, fl_ClickToGoToAndStopAtFrame_6);

function fl_ClickToGoToAndStopAtFrame_6(event:MouseEvent):void
{
    gotoAndStop("menu");
}
```

Ke_ pertemuan 1

```
kem1.addEventListener(MouseEvent.CLICK, fl_ClickToGoToScene_3);

function fl_ClickToGoToScene_3(event:MouseEvent):void
{
    MovieClip(this.root).gotoAndPlay("m1", "Scene 3");
}
```

Ke_ pertemuan 2

```
kem2.addEventListener(MouseEvent.CLICK, fl_ClickToGoToScene_4);

function fl_ClickToGoToScene_4(event:MouseEvent):void
{
    MovieClip(this.root).gotoAndPlay("m2", "Scene 3");
}
```

Ke_ pertemuan 3

```
kem3.addEventListener(MouseEvent.CLICK, fl_ClickToGoToScene_5);

function fl_ClickToGoToScene_5(event:MouseEvent):void
{
    MovieClip(this.root).gotoAndPlay("m3", "Scene 3");
}
```

Fig. 2. Source Code of the Earth Layer Android Mobile Application

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Prior to creating an application, sophisticated features of the ActionScript 3.0 programming language were required. The code was done in Visual Studio, and Adobe Flash coding was used. Encoding execution was beneficial for making upgrading earth layer applications using Adobe Flash or Macromedia Flash (Figure 2).

The Android mobile application of earth layer's look is shown in Figure 3. Because each subtopic is given with an animation effect, the learning of earth layer becomes dynamic, entertaining, and practical. To make it simpler to understand, images, graphics, audiovisuals, and interactive videos material that encourage the shipment of the substance are also integrated. Furthermore, there are guide and navigation buttons that make it simple for users to comprehend the information.


Fig. 3. Interface of The Earth Layer Application

## C. Develop

The purpose of developmental stage is to modify the prototype of earth layer application that was designed in the design stage. The two steps in this stage are an expert appraisal and the application tryout. Expert appraisal or vali-dation was conducted to obtain suggestions for the improvement of the earth layer application. Two experts were asked to evaluate the earth layer application from material content and media performance points of view. Based on their feedback, the instructional package was modified to make it more appropriate and valid to be implemented in a tryout. The results of the expert assessment are presented in Table 4.

Table 4. Experts' Validation Results of the Application

| No | | Aspects Assessed | Average Score | Category |
|---|---|---|---|---|
| 1 | Software | Maintainable | 3.5 | "good": Useable with slight modification |
| 2 | | Media can run properly | 3.5 | |
| 3 | | Media cannot be edited by the user | 3.5 | |
| 4 | | Compatibility | 3 | |
| 5 | Lan- | Complete documentation of learning media programs | 3 | "good": Useable with slight modification |
| 6 | guage | Reusable | 4 | |
| 7 | Audio | The language used is easy to understand for students and standard | 3.5 | |
| 8 | | Does not cause ambiguity | 3.5 | |
| 9 | Visual | The use of voice increases understanding of concepts and makes learning comfortable | 3.5 | "good": Useable with slight modification |
| 10 | | Back sound does not interfere with learning and can be adjusted | 3.5 | |
| 11 | | The use of colour does not cause clutter on the screen | 3.5 | |
| 12 | Naviga- | Images are clear and easy to understand | 3.5 | "good": Useable with slight modification |
| 13 | tion | Video helps users to see events that are difficult to present | 4 | |
| 14 | | The commands in the program are simple and easy to operate | 3.5 | |
| 15 | | Programs have menus and icons | 4 | |
| 16 | Content/ | Menus and icons can be used appropriately and effectively | 4 | "good": Useable with slight modification |
| 17 | Concepts | There are fixed buttons, icons and menus for help, exit, forward, backward, or move to another material | 4 | |
| 18 | | The suitability of the material with the curriculum | 3.5 | |
| 19 | | The truth and accuracy of the concept | 3 | |
| 20 | | The scope of the material according to the level of education | 3.5 | |

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Based on Table 4, it is known that every aspect of the application is assessed by experts and gains an average score of 3.5 which means that the application can be implemented in classroom learning after a slight revision. The earth layer application was also updated in accordance with the evaluator's recommendations to increase the quality. Some of the suggestions given by the validator are, first, the volume of the background sound is too loud and cannot be adjusted so that it can interfere with the user's concentration while studying. Second, the learning videos linked in the application are not inappropriate for the essential competencies set. Third, the type of voice used to fill in the explanation of the material is too fast and not suitable for the education level of the intended student.

The application that had been modified and considered valid was tried out to students. The tryout was conducted to verify the effectiveness of the earth layer application in the classroom. Based on the Table 5, the gained sig. value of 0.000 <0.05, which means that there is a significant difference between students' cognitive learning outcomes before and after being given learning using the earth layer application. The average score of students' cognitive learning outcomes after learning using the application is higher than before learning. In other words, the use of applications in earth layer learning has a significant effect on the students' cognitive learning outcomes. This proves that the developed android mobile application is effective in being implemented in the classroom.

Table 5. T-Test Results

| Score | N | SD | Mean | t-test |
|---|---|---|---|---|
| Pretest | 23 | 17,93 | 48,48 | -7,24 (0.000) |
| Posttest | 23 | 13,63 | 63,04 | |

Based on the define stage of this study, the COVID-19 pandemic is one of the biggest factors causing learning adaptation (Alzamil, 2021). Online learning as the only solution to learning problems during a pandemic, requires teachers to be able to develop learning media that help students learn (Kim et al., 2021; Lastariwati et al., 2021; Wang et al., 2021). According to the researchers, the use of android mobile application as learning media in online learning can enhance students' self-efficacy (Peechapol et al., 2018), improves cognitive activity, promotes learner independence, aids in individualizing learning, and boosts motivation (Kuimova et al., 2018). The usage of android mobile applications in education appears to be on the rise. The problem lies in how the teacher designs the android mobile application to suit the students' needs. The applications should be designed depending on the interests, needs, and levels of the pupils (Gamlo, 2019; Kacetl & Klímová, 2019). Therefore, it is very important to analyze students, assignments, and instructions before designing the application.

In the design stage, the application is created. Applications are composed of pictures and videos related to the material of the earth's layers. The produced earth layer application includes pictures that illustrate scientific topics. This tool facilitates students to understand the science concepts by employing imagery that students are familiar with (Ekanayake & Wishart, 2014). Students connect science concepts with the environment or familiar circumstances as part of the cognitive process. The procedure can help students have a better knowledge of science. One strategy to improve cognitive learning outcomes is to develop students' scientific understanding (Zulfiani et al., 2021). In addition to the photos, the earth layer application also includes video. The earth layer application, for example, contains a film depicting the causes of earthquakes, volcanic eruptions, and tsunamis. The application's video features assist students in comprehending the abstract process. Moreover, student's attention and interest may be piqued by a video presentation. It also facilitates the teacher in maintaining control of the classroom environment (Ekanayake & Wishart, 2014).

Meanwhile, the development stage is the stage where the application is carried out by experts and tested in class. The results of validation and testing in the classroom show that the application of the earth layer is proven to be effective in improving students' cognitive learning outcomes. The findings show that the Android mobile application is appropriate for teaching science on the topic of earth layers. Furthermore, the utilization of earth layer application has been demonstrated to have a good impact on students' cognitive learning results. The study's findings are significant to Zulfiani's research development of science education-adaptive learning system (ScEd-ALS) (Zulfiani et al., 2021).

The study proves that when the experimental class used the Android version of ScEd-ALS compared to the control class, there were substantial changes in learning results. In comparison to auditory and read/write, ScEd-ALS Android based on visual and kinesthetic learning styles are the most effective media (Zulfiani et al., 2021). Furthermore, Ahmed & Parsons, (2013) did a study on learning utilizing Think Learn programs. When compared to a control group who did not utilize the Think Learn app, middle school pupils who used it had much more knowledge and demonstrated more critical thinking. Students who use the Think Learn program remember information/material better than students who do not use the Think Learn application, according to the results of further tests.

The advantage of this research is that the developed application provides a more complete content of material about the earth layers and natural disasters than the previous application carried out by Sunarya et al. (2020). However, this study also has a weakness, namely that the application is not equipped with a quiz menu that facilitates students to evaluate their cognitive knowledge independently.

## IV. Conclusion

Based on the findings of this research, it can be concluded that this study resulted in the creation of a product in the form of Earth Layer Mobile Application. The 4D paradigm was employed in this study's development stage, which included defining, designing, and developing. The expert validation average score of 3.38, which is in good category, shows that the earth layer application is suitable for usage. Further-more, the effectiveness of application can be concluded to be quite effective in enhancing students' cognitive learning outcomes based on the gained sig. value of 0.000 <0.05. Although m-learning appears to be effective in general, learning applications should be designed, planned, and implemented with prudence, according to the needs of students.

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