The Development of Augmented Reality Educational Media Using Think-Pair-Share Learning Model For Studying Buginese Language

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Abstract. Language is a tool used for communication. Indonesia has a variety of languages, one of which is the Buginese language. As a language whose level of speakers exceeds five million, the popularity of this language begins to fade and is rarely used over the times. The Buginese language has its own letter called Lontara which consists of 23 letters. In addition to learning it difficult, educational media to learn this language, especially how to write letters is rarely developed. Learning this language is mandatory for formal school students ranging from elementary school to high school in South Sulawesi. However, a number of teachers noticed that Lontara writing lessons were very difficult for students to understand. Because of the difficulty level of writing, this research was conducted to answer and overcome these problems by developing an educational media called Lontara Augmented Reality. The research and development (R&D) method was utilized as the method in this study and it collaborates with ASSURE as the media development model. ASSURE model is used in the media design process. This media has an embedded learning model which called think-pair-share. The presence of this learning model aims to enhance user skill in learning due to it provides learning with pair features. Educational media design has been validated by four media experts and four content materials validators. Validation result shows the average value 89% with 4.45 in average and total score of 235.75 (very good category). Furthermore, expert material content obtained an average value of 4.74 with a total average score of 99.5. with the percentage of the feasibility of the media reaching 95%. The percentage of usability testing results shows a great result with 96.91% in average and functionality tests around 100% which means that all of these functions this educational media application can work properly. In addition, performance testing and compatibility results show a great result. Memory and CPU usage are in normal conditions and not disturbing the application performance. Lontara Augmented reality compatible in many android smartphones. Around 15 types of devices have been installed and it can run normally in these devices.

Keywords: educational media, think-pair-share, lontara, augmented reality

1 Introduction

Language is a communication and connecting tool in a variety of daily activities. According to the Language Development and Education Agency Ministry of
Education and Culture the Republic of Indonesia and Ethnology there are around 726 languages spoken widespread in many provinces in Indonesia. One of that languages called Buginese language.

Buginese language is one of the regional languages that has the most speakers in Indonesia, which is about 5 million speakers. Buginese language that function as a tool of interaction in society are threatened with a shift to modern language even to be sifted by Indonesian language and become nearly extinct language [1]. This statement is supported by the phenomenon where some people, especially young people, are ashamed to use their own local language such as the Buginese language because they consider it to be out of date. It has own letter called "Lontara". Lontara is an ancient Buginese letter consisting of 23 types of characters and this letter is also used to write the La Galigo script which is the longest epic manuscript in the world. However, there are some complex needs and special skills are needed to write and understand these Buginese letters [2]. In addition, these letters are different from the usual letters, there are separate spellings and writing technique when we want to write some sentences using the letters.

Preliminary observations that have been conducted in several schools in South Sulawesi ranging from elementary school level to high school level, a fact has been found that writing using the Lontara letter is a frightening phantom and is considered very difficult because students should interpret each word of the language Indonesian into Buginese language before write it into Lontara script.

Previous research has provided a general idea that writing and reading on local content subjects in the Buginese language are the second most difficult aspects. When students deal with Lontara script writing material, they mostly find it difficult. In addition, the lack of supporting devices in the learning process of Lontara script makes learning to write and read tends to be difficult for students. Ironically, preliminary research data showed that learning outcomes from 26 students who score below the KKM (Learning Outcomes Minimum Criteria) and only 12 students who score above that standard which is 70. Based on the problems that have been described previously, the application of conventional learning, especially in Buginese language subjects tends to require improvement in the learning process. In order to answer these problems requires a creative strategy to help students understand the subjects in class particularly Lontara script subject. Through interactive learning with educational media that is fun and appropriate learning methods are expected to be able to help students understand the lesson.

2 Related Work

The development of technology changing rapidly brings a variety of educational media that were previously designed, there are various educational applications based on android have been developed. However, the method or function of these system used are totally different. Several systems have been made and developed in various research. Firstly, research conducted by [2] related to the Improvement of Buginese language narrative writing skills with the mind mapping learning model for students garde VII in Ganra Islamic School, Soppeng Regency, Indonesia. In this research, learning mind mapping method is used to facilitate the learning of Buginese language narratives without any learning media being developed and only an implementation of that learning model in the learning process.

A similar study was carried out by [3] an android based game application for writing "Hanacara" java. The purpose of this research is how to teach Javanese script using Android. the concept adopted in this study is Javanese script learning with
applications that can run on the Android platform. However, the implementation of educational media has not provided features related to how to write correct Javanese letters and in its development is not collaborated with the application of appropriate learning models to maximize improvement in learning outcomes.

In addition, the research [4] conducted that examines the introduction of HTML-based Lontara letters. Although the design of the educational media focuses on Lontara letters, the educational media that are designed are also still available on the website platform and do not yet include writing, history and examples of letter use. Lontara in everyday life. Although both studies have focused on learning Lontara letters in the Buginese language, their implementation is still limited to the website platform and cannot yet be accessed using an android smartphone.

Furthermore, research on the design of the Buginese language educational game application and the Android-based Makassarnese language conducted [5] has developed a media that can be accessed on the android platform. However, in this media only provide some exams in the form of multiple choice that are packaged in various levels without any supporting material or learning material. So that in its implementation when users get some difficulties finishing the exams they have to find the correct answer themselves in separate learning source because each question is not completed with an explanation for the correct answer. In addition, the media designed are focused on speaking and writing narrative languages and do not focused on how to use Lontara scripts. Lastly, research conducted which designing an app for learning Lontara scripts using game based learning method [6]. While this research focusing on how to learning Lontara, in learning letters menu is shown only a history of letters and example when them applied with punctuation. There is no explanation about pronunciation and writing procedure each word.

Based on various previous research references, the research intends to accommodate various deficiencies that exist in order to maximize the effectiveness learning process, especially in learning the letters Lontara in the Buginese language. This study designs an educational media integrated with augmented reality and animation technology which aims to enhance the correct procedures for writing and using Lontara letters. In addition, think-pair-share learning models have been embedded in applications, as a result, users can learn together with their pair. This concept is designed to provide maximum learning experience for increasing knowledge about how to understand Lontara letters and its usability in everyday life.

3 Literature Review

3.1 Educational Media

Educational media is a collection of innovation and creativity aimed at supporting a learning process to achieve its goals. Educational media can assist user to implement thinking logically and solving problems [7]. The media can be in the form of sound, images, animations and videos and even some of these media can be combined with each other. The implementation of mobile educational media in teaching and learning process can help educators in various aspects such as student time efficiency in class. Developing educational game that can run in smartphones can help teacher in learning process [8].

There are several advantages of using instructional media in the learning process, which are able to save time on teaching preparation, can motivate students in learning, and minimize misconceptions related to teaching materials [9] However, in the selection of an educational media to be implemented should consider to various aspects such as student character, number of students, learning objectives and basic competencies. The most important indicator in optimizing learning outcomes in class is accuracy in choosing learning media [10]. In order to looking for student
performance in learning, evaluating process such as level of their understanding and competency can be measured using educational game [11]. Utilizing educational in learning process brings some advantages for students and teachers.

3.2 Augmented Reality

Augmented Reality (AR) is a technology that can combine the real world with cyberspace, its nature is interactive according to real time, and its form is 3D [12] other words, augmented reality is a combination of circumstances in the virtual world with the actual real world. As an educational tool, Augmented reality technology has the potential to be implemented in learning [13].

Utilization of AR applications for educational purposes can increase the understanding of the object being studied by students because it provides the effect of real objects. In addition, the use of this technology is able to provide an immersive experience or in-depth experience with anyone who uses it. New experience can be felt by gamers when the game uses Augmented Reality. [14]

The working principle of AR can be seen in Fig. 1 basically simple where the camera device that is shot to the marker (can be in the form of images, barcodes, even real objects such as human faces) then the marker will appear 3D objects or other information previously stored in the database. This 3D object appears because Object Tracker recognizes and matches the marker configuration with 3D objects stored in the database. The following Fig. 1 is a workflow from augmented reality.

![Workflow of Augmented Reality](image)

Fig. 1. Workflow of Augmented Reality [13]

3.3 Buginese Language

Buginese is basically a group of Austronesian nationalities. Austronesian is known as the archipelago language family and is the language group with the widest level of distribution in the world, [15] The Buginese language is part of the main language in South Sulawesi along with three other languages (Makassar, Mandar and Toraja).

Most districts in South Sulawesi use the Buginese language [15] these districts include, Bulukumba, Barru, Pangkep, Maros, Bone, Soppeng, Wajo, Sidrap, Parepare, Sinjai and Pinrang. It is the main language used by people in the area for communicating in their everyday life both informal and formal situations. Fig. 2 shows the map of the spread of Buginese languages in South Sulawesi.
Writing the Buginese language should use Lontara that is a transformation from Indonesian which is interpreted into the language of Buginese. After that, the translation results that have been written in Buginese is written using the letters Lontara in accordance with the spelling based on some certain rules. The Lontara script consists of 23 characters which can be seen in Fig. 3. These letters can be combined with punctuation in writing a sentence.

![Fig. 3. List of 23 Lontara Scripts](image)

### 3.4 Think-Pair-Share Learning Model

Think-Pair-Share (TPS) is a cooperative learning method known as the "Active-Learning Technique" developed by F. Lyman in 1985 from the University of Maryland. This method basically focuses on the collaboration between two or more students in solving a problem related to class lessons. Having a collaborative nature, the implementation of the TPS method in the learning process in class has the main goal of encouraging students to be more active in the teaching and learning process [16].
TPS learning model has Think, Pair, and Share procedures. The exact step is before students submit answers related to questions asked by the teacher first pairing and giving them the opportunity to discuss [17]. If viewed from the process the application of this learning method also has a positive impact on the activeness of students because of pairs and discussions related to the questions asked. Using TPS has a positive impact on increasing student participation in the learning process [18].

Besides being used to learn facts from daily life, the use of TPS learning models also aims to help students store information [19] this is also very suitable for use when the goal is Higher-Order Thinking [20]. High-level thinking is basically related to real-life or the real world about learning and thinking. For example, students will study subject matter such as learning concepts and vocabulary today, tomorrow or in the future the learning outcomes can be well remembered. Higher-order thinking is essentially more than memorizing something where the results of memorization can be described again. Selection of language learning method is particularly subject Buginese Lontara able to give a positive effect on improvement of learning related letters and vocabulary.

4 Methodology

This research basically uses the R&D (Research and Development) method while the learning media development model collaborates with the ASSURE Model. R&D is a method that is oriented to the creation/manufacturing of a particular product and is used to test the product [21]. In education, research and development results can be in the form of models, media, tools, books, modules, evaluation tools and learning tools such as curriculum and school policies [22].

First step is 1) potential analyse or problems where we have found some fact that the main problem is based on student learning outcomes which is is incompleteness in aspect of Buginese language skill particularly in writing using Lontara. 2) The information collection phase aims to gather information related to potential problems that are focusing on this research. The information can be in the form of recapitalizing student learning outcomes, simple analysis results of effectiveness the learning methods used in class and related information on the use of media in the learning process. 3) The design stage is the process of planning and solving problems related to software design. In this study, it collaborates with ASSURE development model. 4) The product design will be assessed whether there are differences in the effectiveness of the previous product [21]. 5) The design revision is a further step of the design phase which aims to improve the design based on the initial design weaknesses obtained from the results of discussions and evaluation with experts. 6) Testing media is conducted to small group for obtain initial data related the effects using the media before implemented in wider scale. 7) Lastly, it implemented in targeted group/end users to analyse the effect of utilizing which some indicators, such as an enhancement leaning student outcomes.

Research methodology R&D which consists of seven main steps. These steps are adopted from standard of R&D that has been modified. it aims to adjust the system characteristic and the main purpose this system created. In stage 3 shows that product design utilizing an ASSURE media learning development model which means that all of steps creating a set of educational get involved an ASSURE model.

Educational media development model utilise ASSURE can be seen in Fig. 4.
(Analyze, State objectives, Select the materials, Utilize materials, Require learners responses and Evaluate). The selection of the ASSURE Development model in this study has several reasons. Firstly, the ASSURE development method has a systematic and effective activity step and in the process of developing this model is easy to understand. In addition, this model involves research objects or students in the development process. Feedback from them is very useful as a reference in perfecting the media designed so that it can have a positive effect, especially on student learning outcomes. Lastly, it is often called a class oriented development model where the application is suitable and effective in classes where there are not too many students and subjects with two hours of learning. The application of this method also has a standard research-based approach so that it can be applied to the pattern of lesson plans in every school [23].

Fig. 4. ASSURE Media Development Model

4.1 Analyse Learners
Student analysis is a stage that aims to gather information related to their characteristics. Analysis of these characteristics related to learning outcomes,
attitudes, learning motivation and learning styles of students at school. This activity was carried out by observation and interviews were conducted verbally with students and teachers in several schools in South Sulawesi. The selection of the school is a place of initial observation because both schools have rules that students must use Buginese language every Saturday in all school areas.

Particularly for learning outcomes, researcher conducted report card grades consisting of scores of knowledge and skills of local content subjects in the Buginese language. From the preliminary analysis activities, compared to other aspects of the assessment, it turns out that there is a significant lack of mastery of concepts in the category of writing skills in the language of Buginese language using Lontara. This collected data will be a reference and reference in developing educational media.

4.2 State Objectives

The determination of the learning objectives of the Buginese language subjects is inseparable from the established competency standards. Learning objectives are usually set forth in the teaching plans programme where these objectives become a reference in the assessment and learning indicators have been successful or not. Success in the learning process is reflected in the achievement of predetermined learning goals.

4.3 Select, Modify or Design Materials

This stage is the process of determining what types of media will be used in the process of media development. In addition, determining the appropriate learning methods and materials contained at this stage the process of choosing there are three stages, (1) determining the appropriate method for a learning task, (2) choosing the form of media that matches the method to be presented and (3) choose to modify or design the material specifically in the form of media [24]. In this study, the development proses utilizing Augmented Reality as technology background and think-pair-share learning model. Fig. 5 shows that story board of media. Both technology based and learning model have been implemented and embedded in media design. AR technology for learning Lontara script and think-pair-share learning model can be seen in pair discussion.

**Fig. 5.** Storyboard of Educational Media

The selection of appropriate methods, media and teaching materials will be able to optimize student learning outcomes and help students achieve competency or learning objectives. In choosing the method, media and teaching materials used there are
several options that can be done, namely choosing existing media and teaching materials, modifying existing teaching materials, and even producing new teaching materials. In software development, one of the most important parts for developing software to run well is the Software Development Model. In the development of object oriented programming software modelling can be described in the form of use case diagrams. The Lontara Augmented Reality education diagram use case can be illustrated in Fig. 6.

![Use Case Diagram of Educational Media](image)

**Fig. 6. Use Case Diagram of Educational Media**

Use case diagrams are representations of interfaces and interactions between actors and systems. It shows that each user can access all the features of the Lontara Augmented Reality education media which consists of six main menus.

### 4.4 Utilize Materials

After choosing methods, media and teaching materials, the next step is to use all three of them in learning activities. Before using methods, media, and teaching materials, instructors or teachers first need to conduct trials to ensure that the three components can function effectively for use in real situations or conditions. This trial was conducted in a small group that has been determined.

### 4.5 Require Learners Response

Learners are involved in the development process. They were asked to provide a response or a response to the system that was temporarily developed. The response can be in the form of comments and assessments of the prototypes provided. At this stage it is not yet part of the actual system evaluation but is limited to gathering information related to the suitability of the system with students who will be the object (end user) of this research. From the results of these responses, the developer can make enhancements/revisions to match the information needs provided by students with the needs that exist in the educational media.

### 4.6 Evaluation

Trial/test of product development is carried out through four stages, namely expert
judgment, individual judgment, one to one trial, small group test, and field evaluation in face-to-face learning [25]. This research utilize these evaluate process to obtain a valid design that suitable for research purpose. There are several testing types that get involved in order to get a valid design, that are design validation and system testing.

5 Result and Discussion
5.1 Design Validation
Studying involved four media experts who had expert background in the design of educational media. All media validators involved have a minimum qualification education levels criteria which have passed their postgraduate level (Ph. D students) and have undertaken at least five years experience in that media development research.

Based on the results of the validation of media experts in the first iteration, an average value of 3.90 was obtained with an average total score of 206.5. Based on the criteria for determining the quality scores, the X value that represents the total score of 206.5 is in the scale range of 180.18 <X≤ 205.05 with a percentage level of media worth 78%. Then it can be concluded that the educational media of Lontara Augmented Reality is in the good category. Even though the assessment of the media experts shows a good category, there are various suggestions and comments from the media experts. These comments and suggestions are the views/perspectives of media experts regarding the designed media

The second validation results for media experts obtained an average value of 4.45 with an average total score of 235.75. X value which represents a total score of 235.75 is in the range of scale X> 222.54 with a percentage level of media eligibility reaching 89% and an increase of 11% from the first iteration. It can be concluded that the educational media of Lontara Augmented Reality is in the very good category. In addition, the results of the expert validation are supported by the conclusions of several media experts that the educational media designed are suitable for use in research without further revision.

Finding out the learning content in the learning media that is being designed in accordance with the curriculum and materials that apply to the teaching and learning process at school, it is necessary to validate the material experts in this study conducted by four teachers. The selection of material experts is based on predetermined criteria which are the material experts are senior instructors at their respective schools and at least have been responsible for five years in mastering Buginese/Lontara letters.

The results of the validation by content experts related to learning content in the Lontara Augmented reality education media obtained an average value of 4.74 with a total average score of 99.5. X value which represents a total score of 99.5 is in the range of scale X> 88.2 with the percentage of the feasibility of the media reaching 95%. Then it can be interpreted that the educational media of Lontara Augmented Reality is in the very good category. It means that the developed educational media has conformity to the curriculum, learning competencies, learning objectives and learning materials that apply in schools. After going through several stages of validation and revision of the initial design of educational media, the final design of educational media is obtained.
In Fig. 7 above is the main menu layout of the Lontara Augmented Reality application. It contains five important parts, these are learning menus, tables, history, discussions and exercises. Furthermore, Fig. 8 shows the display of learn menus which provides a feature where the user is introduced for each letter 23 in total in the Lontara letter list. In addition, users will also find four sub menus, namely voice / letters pronunciation, pairs of punctuation marks for each letter that appears, Lontara letters displayed in 3D form and animated procedures for writing correct letters Fig. 9 that can only be accessed by directing to special markers.

![Fig. 7. Main Menu](image)

![Fig. 8. High Definition 3D Lontara Letters](image)

![Fig. 9. Writing Animation Procedure](image)
Fig. 10. Discussion Menu

Fig. 10 is a discussion menu display of the educational media application. This menu is also called Think-Pair-Share Trigger Embedded System which in this section is the first step in implementing the learning model adopted in this study, Think-Pair-Share. In accordance with the aim is to activate the learning model in the classroom, students are first grouped into pairs of 2 persons each group. After that they must write the name of the object that appears in Indonesian, then write the name of the object in Buginese using Latin letters. Finally, they write the name of the object in the Buginese language by using Lontara letters, the whole activity is written on a paper that has been provided with a certain format. After finishing writing, each group is required to present the results of their discussion in front of the class.

Fig. 11. Table of Lontara Letters

The table displays all Lontara letters that can be seen in Fig. 11. Besides having the letters on this page, they also display the names of letters and punctuations which provides the user learning experience for understanding Lontara letters.
The total number of questions for this menu is 10 questions in the form of multiple choices with a certain timing procedure (Fig. 12). The questions created are inseparable from the overall content in the educational media and are designed to represent every aspect of learning in learning the letters Lontara. In addition, questions are displayed in sequence with random answer choices where if the user tries to repeat working on this menu they will be faced with choices of answers that change each session of work on the question. The design of questions like this is intended so that users are able to analyze and understand even though the answers are in different positions.

History menu displays both the history of Buginese language and the history of utilizing Lontara script by the ancient people in the past. In addition, application developers also provide additional knowledge that the letters Lontara are the letters used in writing the longest script in the world (I La Galigo) with the aim of adding a new insight into the users.
5.2 System Testing
The development of a system must consider various important aspects, including those related to the quality of the system. In the process of developing the system is inseparable from a variety of tests conducted which aim to see the mistakes and weaknesses in the system being developed.

5.2.1 Functional Testing
Overall functions that have been listed in the system design are tested using Test case. When the development process done, list of functional requirement should be listed [26]. This test involves several experts who have professional background as software developers with certain criteria. These criteria are that there is a minimum of five years work experience in the field and have made applications that run on the Android platform. The result of functional testing can be seen in Table 1.

| No | Testing Components            | Number of Software Tester |
|----|-------------------------------|---------------------------|
|    |                               | A1 | A2 | A3 | A4 |
| 1  | Next Button                   | OK | OK | OK | OK |
| 2  | Previous Button               | OK | OK | OK | OK |
| 3  | Confirmation Button           | OK | OK | OK | OK |
| 4  | Cancel Button                 | OK | OK | OK | OK |
| 5  | About Button                  | OK | OK | OK | OK |
| 6  | “Belajar” Button              | OK | OK | OK | OK |
| 7  | Speaker Button                | OK | OK | OK | OK |
| 8  | Punctuation Button            | OK | OK | OK | OK |
| 9  | 3D Button                     | OK | OK | OK | OK |
| 10 | Animation Button              | OK | OK | OK | OK |
| 11 | Back Button                   | OK | OK | OK | OK |
| 12 | “Diskusi” Button              | OK | OK | OK | OK |
| 13 | Table Button                  | OK | OK | OK | OK |
| 14 | Table-Next Button             | OK | OK | OK | OK |
| 15 | Table Previous Button         | OK | OK | OK | OK |
| 16 | “Latihan” Button              | OK | OK | OK | OK |
| 17 | Back Button                   | OK | OK | OK | OK |
| 18 | Next Button                   | OK | OK | OK | OK |
| 19 | Zoom of Question              | OK | OK | OK | OK |
| 20 | Multiple-Answer Choices       | OK | OK | OK | OK |
| 21 | Timer                         | OK | OK | OK | OK |
| 22 | “Sejarah” Button              | OK | OK | OK | OK |
| 23 | History Next Button           | OK | OK | OK | OK |
| 24 | History Previous Button       | OK | OK | OK | OK |
| 25 | Apps Instruction Button       | OK | OK | OK | OK |
5.2.2 Usability Testing
Usability means the end-user response to the system. In this study end-users of educational media are students who have become a predetermined group. They are elementary school students in class V (level five) and VI (level six) in SD Negeri 1 Pakalu 1, South Sulawesi, Indonesia. A total of 55 students became respondents and have used the Lontara Augmented Reality education media application for approximately 15 days with an allocation of 3 face-to-face meetings in class. The questionnaire used as a research instrument was adapted from the USE Questionnaire by Arnold M. Lund and CSUQ Questionnaire by J.R Lewis [27].

Table 2. Usability Testing Result

| Usability Aspects           | Mean | Standard Deviation | Results (%) |
|-----------------------------|------|--------------------|-------------|
| Usability                   | 4,88 | 0,138              | 97,59       |
| Ease of Use                 | 4,85 | 0,101              | 97,02       |
| Ease of Learning            | 4,83 | 0,204              | 96,64       |
| Satisfaction                | 4,80 | 0,168              | 96,05       |
| Quality of Information      | 4,86 | 0,137              | 97,25       |
| Overall Result              | 4,85 | 0,150              | 96,91       |

The results of the usability test table 2 shows the usefulness of the system which is classified into five aspects, usability, ease of use, ease of learning, satisfaction and quality of information. All of these aspects have a presentation level of usefulness of more than 90% with the lowest value found in the aspect of satisfaction which is 96%, although the value is still classified as a relatively high presentation.

5.2.3 Performance Testing
The system designed must have reliable performance in order to run smoothly, quickly, stably and efficiently without any errors when utilization process by users. This study adopted an automation testing system to measure performance levels using
the automated test platform Testdroid by Appium Automation Testing. For the test results can be seen in Fig. 14 & Fig. 15.

![Memory Usage](image1.png)

**Fig. 14. Memory Usage**

The memory calculation in Fig. 14 shows that memory usage at 0-51 seconds has experienced a very significant increase because educational media is being opened and is loading data on the application. After 51 seconds, the memory usage is stable and there is no significant change in memory allocation. Average memory usage in the range of 67-124 MB. Even though there is a fairly large allocation of memory usage, the educational media application does not cause a memory leak that makes the application to stop suddenly (force closed) and is still in the normal category.

![CPU Usage](image2.png)

**Fig. 15. CPU Usage**

Fig. 15 can be seen a description of CPU usage at times from 0-54 seconds has increased very significantly by 30% because educational media is being opened and is loading data on the application. At the next 51 seconds the CPU usage is seen to decrease by more than half the CPU allocation time of the previous 12%. Furthermore, the average CPU usage range is 5-11% which means that CPU usage is within reasonable limits and is still below the maximum standard set by the Little Eye international standard of no more than 15%.

### 5.2.4 Compatibility Testing

Educational media is used to learn for each user, which means that even though they have different devices, the application can run on these devices without any problems. This days, there are various types of mobile phone products that are different in terms of qualifications. For example, differences in OS (Operating System), CPU, and various screen resolution. The result of this testing can be seen in Table. 3. The
compatibility test in this research is to see the level of compatibility of educational media applications developed with various devices that have different characteristics.

**Table 3. Compatibility Testing Result**

| No | Device Type            | CPU                  | Operation System (OS) | Display/Screen Resolution | Result  |
|----|------------------------|----------------------|------------------------|---------------------------|---------|
| 1  | Xiaomi Mi Max 2        | Octa-core 2.0 GHz    | Android 7.1.1          | 6.4"/1080 x 1920 pixels   | Compatible |
| 2  | Huawei Y6 LTE          | Quad-core 1.1 GHz    | Android 5.1.1          | 6.1"/720 x 1560 pixels    | Compatible |
| 3  | Lenovo K320T           | Quad-core 1.3 GHz    | Android 7.0.1          | 5.7"/720 x 1440 pixels    | Compatible |
| 4  | Samsung Galaxy Tab 2018| Quad-core 1.4 GHz    | Android 8.1.0          | 8.0"/800 x 1280 pixels    | Compatible |
| 5  | Asus Zenfone Max Pro   | Quad-core 1.3 GHz    | Android 6.0.1          | 7.0"/600 x 1024 pixels    | Compatible |
| 6  | LG-G4 C                | Quad-core 1.2 GHz    | Android 5.0.0          | 5.0"/720 x 1280 pixels    | Compatible |
| 7  | Samsung Galaxy A30     | Octa-core 2x1.8 GHz  | Android 9.0.1          | 6.4"/1080 x 2340 pixels   | Compatible |
| 8  | Huawei Honor 4X        | Quad-core 1.2 GHz    | Android 4.4.2          | 5.5"/720 x 1280 pixels    | Compatible |
| 9  | Samsung Galaxy J5 2016| Quad-core 1.4 GHz    | Android 6.0.1          | 5.0"/720 x 1280 pixels    | Compatible |
| 10 | Tab Advan X7 Pro       | Quad-core 1.1 GHz    | Android 5.1.0          | 7.0"/600 x 1024 pixels    | Compatible |
| 11 | Xiaomi Redmi 4A        | Quad-core 1.4 GHz    | Android 6.0.1          | 5.0"/720 x 1280 pixels    | Compatible |
| 12 | LG-G3 D850             | Quad-core 2.5 GHz    | Android 4.4.2          | 5.5"/1440 x 2560 pixels   | Compatible |
| 13 | Samsung Galaxy S6      | Quad-core 1.4 GHz    | Android 5.0.2          | 5.1"/1440 x 2560 pixels   | Compatible |
| 14 | Asus Zenfone Max Pro   | Octa-core 1.8 GHz    | Android 8.1.0          | 5.9"/1080 X 2160 pixels   | Compatible |
| 15 | Vivo Y83              | Octa-core 2.0 GHz    | Android 8.1.0          | 6.2"/1520 x 720 pixels    | Compatible |

### 6 Conclusion and Future Work

To sum up, based on research that have been conducted related to development of Augmented Reality educational media we have found some facts and findings. Firstly, Educational media design had been validated by four media expert and four content materials validator. In the first iteration of validation, average value of 3.90 was obtained with an average total score of 206.5 and total percentage around 78% (good category). After media being revised, an increase of 11% from the former iteration become 89% with 4.45 in average and total score of 235.75 (very good category). Furthermore, content material experts obtained an average value of 4.74 with a total average score of 99.5, with the percentage of the feasibility of the media reaching 95%.

System testing result depicts that all of categories obtained an adequate result. The percentage of usability testing result shows a great result with 96.91% in average and
functionality test around 100% which means that all function in this educational media application can work properly. In addition, performance and compatibility testing result shows a normal activity. Memory and CPU usage are in normal condition and not disturb the application performance. Lontara Augmented reality compatible in many android smartphones. Around 15 type of devices have been installed and it can run normally in these devices.

The future work is to find out the effect of using Lontara Augmented Reality educational media in wide scale group. This effect will be the learning outcomes of students. Media developed initially for Android platform an it will be better if there is development for iOS devices.

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