ENHANCING SCIENCE LEARNING EXPERIENCE BY ADOPTING 3D MODEL IN MOBILE LEARNING APPLICATION – CASE STUDY ON SENSES AND BLOOD CIRCULATORY SYSTEM

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Abstract

Science commonly stated as a difficult subject for the student to learn and for the teacher to deliver. One of the problem often arose from the fact that students sometimes cannot visualize the object which the teacher trying to describe. This problem cause minimum engagement inside the classroom. Since most people can perceive visual better than auditory, therefore without visual aid, the learning process somehow disturbed. Good teachers occasionally would bring visual aids to support their explanation on science subject, however most of those visual aids was in 2D which often fail to bring clear picture of the object which originally in 3D. By engaging 3D modeling technology in the creation of mobile learning application, student will be equipped with more realistic visual aid to help them grab a better understanding of science while study with their teacher or independently. This paper presents a model to combine 3D model and mobile technology in overcoming learning difficulties in science subjects.

Keywords: science, 3D, mobile application

INTRODUCTION

In Indonesia, science subject appreciated as an important subject by students, teacher or people in general. However, the image of this subject has been always unappealing for the students since it has the reputation of being a difficult subject and this subject has been always be a challenge for the teacher as well. The result of this condition was pretty obvious as can be seen from the result of PISA Test 2012 which show an unimpressive result for Indonesian student in science with the mean score of 382 and reach the bottom two of the list (OECD, 2014). This poor result actually was not the first time for Indonesian students to obtain, as the similar outcome has been gained from the previous tests at 2009 and 2006.

Towards previous situation, the school educational system has always been criticized as the root cause. Having said that, science subject itself has a nature to make it difficult to learn (Johnstone, 1991) with its daunting information to be perceived which resulted in memory overload, too much to receive and not enough space left to grasp and think about it (Johnstone, 1997). Moreover, student's lack of confidence and self motivation seldom make it even harder for both teacher and student to engage aptly in one learning event. Millar (1991) argue that student find it really hard since it was not presented clearly, therefore it needs more effort to be fully grasped. Despite efforts has been made by the students, the result mostly quite disappointing and this poor result which is not worth the effort made would degrade the motivation of the students. The education system applied in many places was not helping, since the fat curricula made the teacher most of the time only care about how to finish them in available time frame and pay little attention on how the student learning process (Bahar and Palat, 2007). Moreover, students were not engaged into the learning process itself while there was only little effort from the teacher to maintain conducive learning environment. A class with too many students or too little equipments made the presentation of any science subject is not clear and hardly digested by the students. All of the problems uncovered have been pointing toward two main issues, which are the lack of engagement and the lack of presentation.

Several times the government of Indonesia through the department of education and culture has been trying to assemble regulations for a better education system. The last regulation from 2016 stated that the education process should not regard teacher as the solely resource, on the contrary students ought to elevate the learning process by the means of multiple resources (Kementerian Pendidikan dan Kebudayaan, 2016). Moreover, it also encourages the usage of information technology to improve efficiency and effectiveness in learning process. In other words, the government has been trying to address the issue of insufficient formal learning experience by allowing teacher to persuade students to collect more assist from other resources available, particularly using the information technology resources.

That regulation is corresponding with the fact that internet in general and mobile technology in particular has reach significant growth on the last few years. The growth of mobile technology recently brought more attention to the possibility of the utilization of mobile technology in many field. While expert cannot dispute the ugly implication of children's exposure to this technology, the beneficial of it hardly to be taken aside (Sharkins, et.al., 2015). Therefore rather than reject the usage of mobile technology on children completely, caregivers were suggested to use it wisely and maintain its applications for the beneficial of the children. In response, educators has been interested to employ mobile device in 1:1

education system, in which student would be equipped with mobile device. A research project had been conducted by converting the old science delivery method to a new mobilized delivery method (Looi, et.al., 2010) and the result of this project which has discovered through a traditional assessment confirm that this new method bring a better study result. This result may due to the characteristic of mobile learning which promotes self-regulated learning (Sha, et. Al., 2011) where the student able to determine his own learning pace and maintain it toward his own target.

Based on the problem about science learning stated previously whereas the opportunity and positive result of mobile technology for mobile learning is openly presented with the encouragement through the regulation in teaching, the research question would be how to employ mobile technology to overcome the difficulty in science learning? This paper would present a model in which mobile technology assisted by 3D technology adopted as a tool to vanquish difficulties coped in science learning.

METHODOLOGY

This research started by gathering data related to recent problems dealt by students and teachers in science learning. Surveys had been conducted with sampling size 39 students. To collect information from the teachers, interviews had been carried out as well. Data assembled from surveys and interviews would be analyzed and the result would shape the design process.

Some quizzes has been taken with the participants were students from fourth and fifth grade of elementary school about some science subjects. The result of this assessment would be employed to make a decision regarding science subject to be handled as a case study on this research. The result of the previous quizzes show that topics about senses and blood circulatory system where equally reach the lowest average score among the others, both subject's average scores were 41.43 out of 100. Therefore topic about senses and blood circulatory system would be adopted as the case to be mobilized learning module.

Afterwards, analysis about science learning difficulties, especially in senses and blood circulatory system, carried out by first conducting a survey to students about their difficulties in learning and their learning behavior. From the survey, it seems that 19 out of 39 students (49%) admitted that science about senses is difficult to learn. Blood circulatory system apparently considered as tougher science subject since around 72% students find it hard to learn. While self-probing their own difficulties in learning, 15 out of 19 students (79%) who find the senses subject is difficult stated that they cannot clearly picture material has been delivered by their teacher. Similar outcome came from the students who find the blood circulator subject is hard to learn, in which 17 out of 28 students (61%) inform that it is hard to imagining the whole information given by the teacher. Hence, the biggest obstacle in science learning is the presentation problem which is not sufficient for delivering information.

When questioned regarding their learning behavior, there was no dominant preference on learning behavior among the students. Moreover, most of them have multiple preferences of learning method. Some students (23 out of 39) enjoy listening explanations from the teacher, this students are the auditory type learners. Learning using their computer or tablets is quite popular as well since 18 out of 39 students were favoring that method. Another popular method is reading books either a textbook of the subject (16 out of 39) or another book (12 out of 39). Only a small group of students (7 out of 39) using props provided in school as the medium of learning. In conclusion, the result show that students trying to learn science using multiple methods. Having said that, the result also point out that their favorite approaches are the auditory method, reading, and using information technology.

Based on the interviews with the teachers, it can be concluded that the teachers already aware about the lack of presentation during science learning. Having said that, time and budget constraints disallow them to have more props for the presentation or to let each of the students have enough time to make use the props. Beside the little number of the props, the vulnerability of provided props was made them treated as precious, thus student cannot freely utilize it for learning purpose. Amongst the body system subjects, blood circulatory system found to be the hardest one to be delivered due to the inadequate props available to demonstrate the system. Again, the problem has been spotted here is the lack of presentation during science learning.

The requirements of the mobile learning application for science can be concluded from the result of previous stages. The mobile application should address the issue of insufficient presentation, and not merely a nice picture or sophisticated animation which explain nothing but looks good, the presentation should be adequate to deliver the information required to understand about senses and blood circulatory system. In addition, there should be some kind of interactivity embraced in the application to increase the engagement level with the students. Pintrick (2002) point out that metacognitive which is the way one arrange and commit to their own learning, that is recognize their own achievement and arrange their own learning strategy, play an important role in learning accomplishment. To facilitate metacognitive process, in this application students should be able to study on their own pace and have some kind of control regarding their own study system.

The next phase of this research was the design of mobile learning application for senses and blood circulatory system. The design of this application followed the previous requirements found through the analysis stage. To enhance the explanation throughout the material, multiple media would be used simultaneously. The usage of multiple media was decided in view of the finding by Shams and Seitz (2008) which indicate the importance of multisensory activation to enhance optimal brain activity in learning and achieve the highest possible result. At the same time, to elevate user's engagement and metacognitive process, each part of the application should promote user freedom to control the whole learning process.

The information about senses and blood circulatory system would be conveyed through text, image and audio. Text can be used to explain information in detail in the form of words and sentences. The target user for this application is

Indonesian student, therefore throughout this application in every delivering tools, the language used would be Bahasa Indonesia, which is the national language of Indonesia. The amount of text in a single frame has to be maintained to promote comfort learning. User should have the freedom to move from one frame to another. Images which employed as visual presentations in this application would be 3D images since the object itself such as eye, nose, mouth, heart, etc; are basically 3D objects. Therefore as a replacement of unavailable physical props, the information would be accompanied with 3D images of the objects. Moreover, to ensure that every part of the 3D object can be observed thoroughly, user need to be able to interact with the application by rotating 3D images to different angle as if they move and rotate props. There is no evidence about the association between animation and learning success (Daly, et.al, 2016), hence animation is not compulsory. Animation itself can be the source of attraction but at the same time it may be the source of distraction in learning as well. When an animation involved in a learning media, it has to be related to the subject taught and has to be meaningful, otherwise it will not increase the learning curve, instead it only stir up the learning process and make it ineffective. Therefore, we decided it is not necessary to put any animation on the 3D objects of senses organs other than the manually movement which is controlled by the user. On the other hand, blood circulatory system involved movement in the reality, because of that we decide to add animation of the circulation of blood since this movement can described better using animation rather than merely verbal or text.

Audio in this application would be used as an addition that helped convey the information for auditory person. When people read about science in text only, the presentation is not adequate to make them understand. However, text and image are both visual presentation and required the same sense to be active. If they are both presented at the same time, sometimes the brain are overloaded (Herrlinger, et.al, 2016) since it need to take care to more than one data from the same tool at the same time. Therefore, if another sense is activated, the brain would digest the information more optimal. Based on their preferable study method, user can choose to read or listen to the information while observing the 3D image provided.

From the previous analysis, students typically enjoy listening the explanation from the teacher, thus in this research, a 3D character required to assist students throughout learning process. Children with the age above ten years old prefer a human character is more preferable rather than animals which is more appropriate for younger children and considered silly for this range (Morgan, Ponticell, and Gordon, 1998). The character created should be shaped to make it believable to deliver science subject. It would resemble a real life good teacher which students are comfortable with, as can be seen in Figure 1. Since this character would be a representation of a teacher, it would animate slightly just to make it more humanlike.

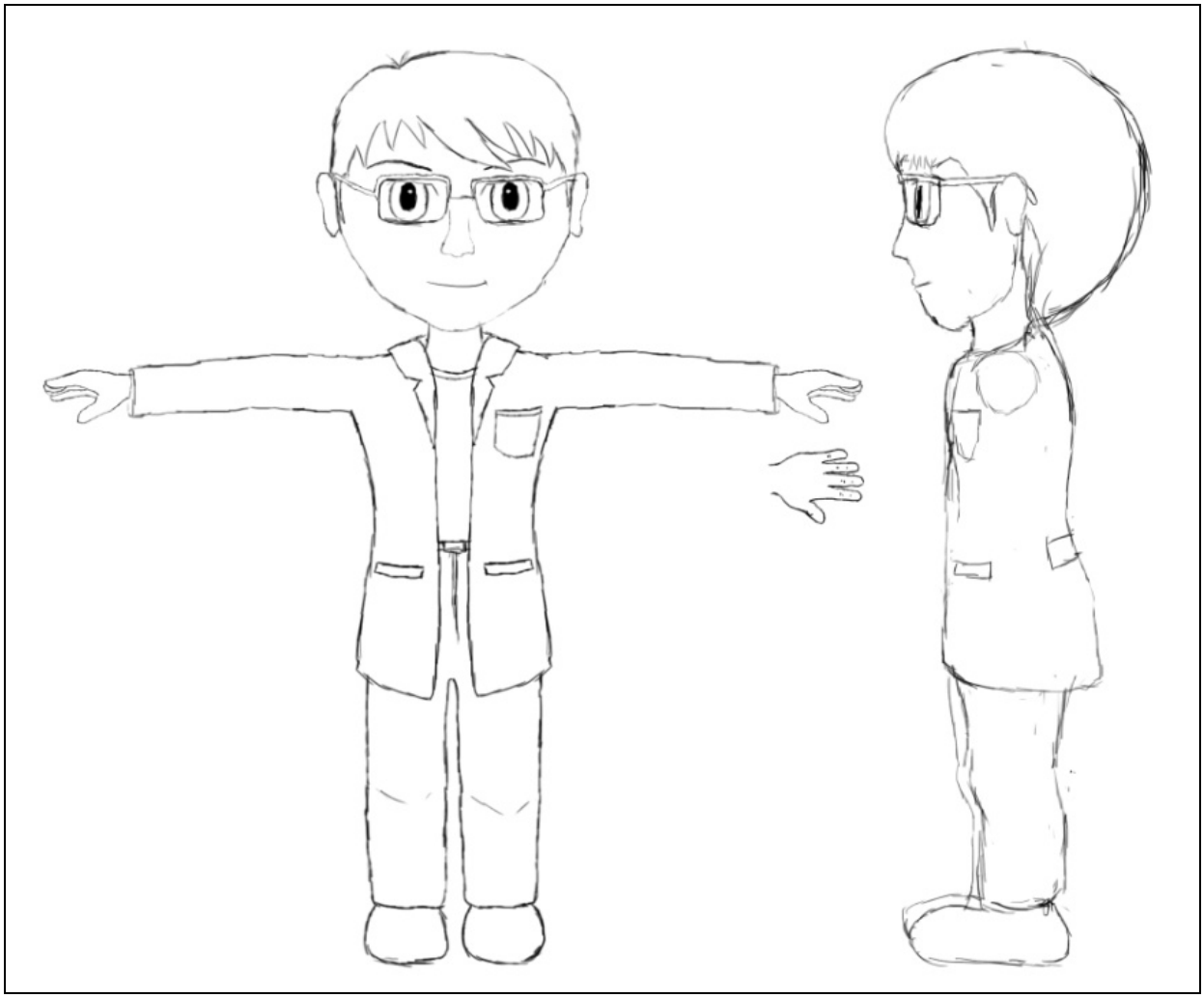

Figure-1. Character Design of Teacher

The implementation process would be started by creating all 3D objects; which are the 3D character, every senses organ such as eye, nose, ear, etc. and blood circulatory system organ such as heart. Each part of each organ should be created separately to make it possible to be explained separately as well. This process includes modeling, texturing, morphing, rigging, skinning, animation and rendering. Following the previous design process, animation would be applied on the teacher character and blood circulatory system. Figure 2 show the morphing process on teacher character. This phase followed by constructing all other visual assets required, such as buttons and background.

Figure-2. Morphing on Teacher Character

The audio of this application would be the text reading of overall explanation which displayed as text as well in Bahasa Indonesia. The creation of audio content started by setting the tools before audio recording, and then followed by the recording process itself. The result of the recording process need to be adjusted to make it clear and had the desirable tone.

When all the visual and audio assets has already prepared, the process continued by compile them together along with the script required to build a mobile learning application. Some of the content required saved as an XML file which can be accessed through the application. To rotate the 3D object, the sequence of the whole rotation saved as image sequence, and based on the x-axis difference between the mouse down and the mouse move the correct frame number would be presented.

As soon as it had implemented and appropriate verification had been taken place, the next stage required would be the evaluation and validation process. Children from the fourth and fifth grade elementary school would be tested using a set of question regarding senses and blood circulatory system. The test would be conducted before and after they use the application. The result of both test would show weather the application sufficient to assist user's independent learning. To find out if user find this application appealing and consequently engaged to it, we provided some other application to different set of children and let them state their opinion towards each application and choose the most agreeable application at the end of the interview.

RESULT AND DISCUSSION

This research has been conducted to find a suitable way to help science learning using mobile technology. As stated previously, the problem had been discovered through the analysis which is supported by some studies is the lack of engagement due to the lack of motivation, which can be traced to the lack of presentation of science learning delivery method. As an answer to that problem, the solution designed as a mobile learning application which demonstrates the science subject using 3D model combined with text and audio to achieve multisensory learning. The 3D model can be rotated to let user inspect it thoroughly. Furthermore, it also promotes interactivity to maintain user engagement and support metacognitive learning. Implementation of the design had been carried out by building 3D objects, animate some of them and merge them along with the script. One part of the senses subject implementation, which is about eye as the vision senses organ can be seen in figure 3. The page shown below is located on the menu "Alat Indera" (Senses) tab "Bola Mata" (eyeball). It shows the explanation about parts of an eyeball such as cornea, iris, pupil, etc.

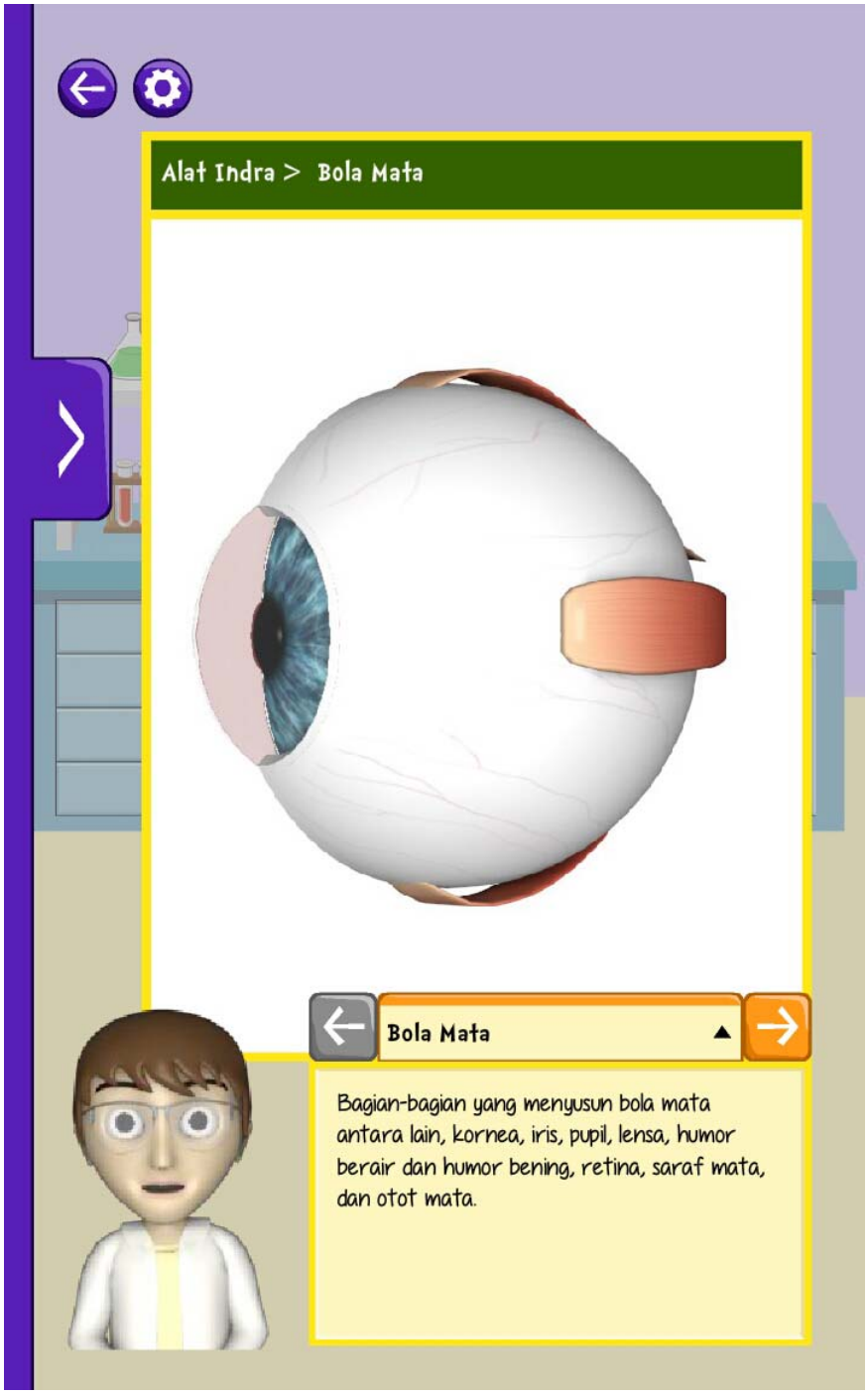

Figure-3. Implementation on Vision Organ

Thirty students from fourth and fifth grade of the elementary school undergo pretest about senses and blood circulatory system. Afterward, they were requested to learn about senses and blood circulatory system using the mobile learning application built previously. When they finished their learning process, they would be examined once more through the post test. The result of pretest and posttest can be viewed in table 1. The average score of the senses pretest was 48.67 with the highest possible score is 100, while the average score of blood circulatory system was even lesser at 36. The result has been greatly improved as the average score of the senses posttest reach 84.67 while the average score of blood circulatory system posttest obtain even greater result at 90. The scores increased around 74% and 150% for senses and blood circulatory system respectively. From the evaluation using pretest and posttest for the children, we can presume that the mobile learning application using interactive 3D model able to help student understand science subject about senses and blood circulatory system better as we can witness from the increased of their test result.

Table- 1. Pretest and Posttest Result

Mark	Senses		Blood Circulatory System	
	Pretest	Posttest	Pretest	Posttest
0	-	-	-	-
10	-	-	1 student	-
20	-	-	2 students	-
30	3 students	-	4 students	-
40	3 students	-	4 students	-
50	5 students	1 student	3 students	-
60	2 students	2 students	1 student	1 student
70	1 student	1 student	-	1 student
80	1 student	2 students	-	2 students
90	-	3 students	-	4 students
100	-	6 students	-	7 students

The subsequent part of the evaluation carried out by providing several applications about senses or blood circulatory system alongside with the application created to separated different group of children. None of the other applications are created in 3D and none of them using human voice audio as well.

Almost all of the children interviewed are in favor to the new application created except one student which stated that he can learning and understand every material provided using any of those application. The other students only choose one application which they describe very easy to learn, that is our new mobile learning application. They admit that it is easier to listen to the explanation rather than has to read them all. In addition, they also point out that they like to play with the 3D object by rotating it and they acknowledge that the activity make the explanation more understandable.

CONCLUSION

The conclusion of this research is that 3D model objects had proven effective to be applied in mobile application learning about science, particularly on the subject of senses and blood circulatory system, since it could give a better presentation of the subject, gain more engagement and the interactivity is inline with metacognitive learning. Multisensory learning through the utilization of more than one sense in learning; text and image for the sight, audio for hearing, and interactivity for touch; had proven able to enhance learning curve.

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