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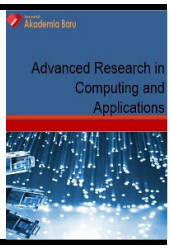

In Situ Observation and Acceptance Measurement of Collaborative Augmented Reality in Education Field of High School Students

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ABSTRACT

The use of Augmented Reality (AR) is involving a new way of interaction. This interaction is including the devices and technology, that probably is still unacceptable by our society. Some of the previous research have discussed the importance of the technology acceptance and social acceptance of AR use. This research conducted an in situ observation at high schools that involved its students and teachers as respondent. The method of this research is a data analysis of video recorded activities and a semi-structured interview. The recorded videos contain the records of the activities of the respondent while using AR application. The result showed that each respondent from observation groups felt a new experience when they learned with AR application.

1. Introduction

1.1. Background

Augmented reality is a combined interaction of reality and virtual objects inside an interactive environment, and it integrates things in three dimensions into the real world [1]. Augmented reality has been widely applied in education, design, manufacturing, construction, and entertainment[12]. Unfortunately, one of the problems is, this kind of interaction can sometimes be rejected by society. For example, the implementation of augmented reality glasses, which created privacy issues [5]. There were some researches about the problems of augmented reality. According to Azuma *et al*., [2] the main obstacle in augmented reality was technological limitation, interface limitation, and social acceptance limitation. Social acceptance became the main concern in the development of augmented reality. In previous research, stated that the acceptance level in medical is very high [7][8], reached 85%, but there is still few research which measure the acceptance level in social field[11].

Regardless of the problems posed, now augmented reality is used as a new method in improving learning outcomes in education field [4][14].

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Regardless of the problems posed, now augmented reality is used as a new method in improving learning outcomes [4] the benefits gained are heightening students attention, gives a more attractive and effective learning, improving motivation, providing richer interactions, facilitates learning, increasing student involvement, enhancing cooperation, developing imagination, and enhancing spatial abilities [10]. Despite numerous research and applications of augmented reality in the field of education, until now there is still no research that tries to discuss social acceptance in high school environments, especially in Indonesia. Since the measurement of acceptance of technology and social acceptance are not suitable in the laboratory environment, this research will conduct in situ observation techniques [5,7] in the classrooms of a high school.

Interactions and conversations that occur will be recorded and analyzed to identify social issues. After the recording session is over, the questionnaires are categorized into 3 categories of respondents, i.e. students who used the application and those who only observed. The formulation of the problem in this research is to know the acceptance level of high school academicians toward the application of augmented reality in the field of education by considering how they interact through the technology of augmented reality.

This research is conducted to measure the level of acceptability in the application of augmented reality in the field of education by using the analysis of questionnaires and video observations.
This research is expected to know the level of augmented reality acceptance in the education field and the influence of augmented reality application towards teaching and learning process with new interaction. This research was conducted only in one class, class X-6. The sample number of respondents in this study were 12 users and 5 observers.

2. Methodology

The research method is divided into 4 stages: Application Selection, Pre-observation, Respondents Profiling, and Observation.

2.1 Application Selection

In this research, the selected application is Elements 4D. Elements 4D is a set of interactive blocks that could assist students in studying the periodic table by showing the process of elements combining into a new substance, showing the reactions of these elements, and the result of a chemical process. The interaction of the 4D Elements application can be seen in Figure 1.

Fig. 1. Augmented reality interaction on blocks

2.2 Pre-observation

The stage of pre-observation contains the preparation of observation instruments. The things that have to be prepared are the Creation of Respondent Profiling Questionnaire to obtain the personality of the respondents, the Preparation of Observation Technical Document to decide the exact technical planning of the observation will be made, and the Creation of Acceptance Questionnaire is done as an assessment material of user acceptance to the application of augmented reality.

The concepts of questionnaire questions include:

1. Usability
   This category measures on how well the quality of the application of augmented reality when it is used by the user in completing tasks [9].
2. Technology Acceptance
   This category measures the level of acceptance of the user towards the technology innovations in augmented reality in education [3,13].
3. Social Acceptance
   This category measures the acceptance of users on the development of augmented reality as a medium to socialize and collaborate with other users [5].

2.3 Respondents Profiling

Profiling was performed before the observation was conducted to obtain the characteristics and the respondent's habits in using the application. This stage is done on student respondents in Bogor Chemical Analyst High School (BCAHS). This profiling was conducted a week before the observation. Profiling of respondents is expected to classify users as those who have high or low technological literacy.

2.4 Observation

At this stage, the collection of data is conducted. The method of collecting data used in this research is observation through video analysis (in vivo) and filling out the questionnaires by respondents. The observation was conducted in the classroom of BCAHS for a school day and the students who are in the 10th grade as the respondents. 12 students in each class participated in order to use the application, Elements 4D, and the teachers were asked to supervise the students in using the application. The data are collected by giving out the acceptance questionnaire. The purpose is to make the research focus on the main issues of social acceptance. Meanwhile, the data which is collected in the form of video recording is using in vivo techniques [6].

3. Results and Discussion

3.1 Pre-observation Analysis

This questionnaire is given to 12 students. There are 28 questions in this questionnaire which are divided into 3 categories, 10 questions in the usability category, 9 questions in the technology acceptance category, and 9 questions in the social acceptance category.

3.1.1 The user acceptance questionnaire

The data of this questionnaire is conducted on 12 students. In the user questionnaire, there are 28 questions which are divided into 3 categories.

3.1.2 The observer acceptance questionnaire

The data of this questionnaire is conducted on 3 students and 2 teachers who only observed. In the observer questionnaire, there are 15 questions which are divided into 6 categories.

3.2 Respondents Profiling Analysis

The selection of respondents of this research was conducted by providing a questionnaire of profiling respondents conducted on October 28, 2016 in the X-6 Class of Bogor Chemical Analyst High School (BCAHS). Selection of respondents obtained from one class of 31 people who then selected to 12 respondents based on the questionnaire result from the assessment of technology habit of the respondent. In 31 student respondent data, there are 20 students who have known augmented reality and 11 students who have not known augmented reality yet. There are 17 questions in profiling respondent questionnaire. Questions 1 to 3 are basic questions about respondents' habit in using a smartphone daily. This questionnaire is divided into 2 categories, the users who have known augmented reality are required to fill all of the questions, while users who do not know augmented reality can go directly to Questions 16 to 17.

Furthermore, in this profiling process is done by calculating the scores on each question. The results are then sorted and taken into the top 6 student scores from the category of students who already know augmented reality or who do not know augmented reality.

From the results of this profiling, 12 students consisting of 10 male and 2 female have been obtained. After obtaining respondents, the observation groups will be divided into 4 groups that later will be observed. The division of this group is done by randomizing respondents based on the answer of profiling respondent questionnaires from two categories. In addition to student respondents as users, this observation also involves students and teachers as observers of the use of application augmented reality. Student observers in this observation consisted of 3 students of class X-6 and for teacher observers consisted of 2 respondent teachers in class X.

3.3 Augmented Reality User Analysis

Based on the data collected on November 4th, 2016, 3 categories of respondents were obtained. The data consisted of acceptance questionnaire from the students as users, acceptance questionnaires from students as observers and teacher acceptance questionnaires. The submission questionnaire was conducted after the observation and recording stages.

Fig. 2. Giving observation instruction

Table 1 shows the descriptive analysis of six concepts. Overall, users welcome the positives on the augmented reality application in the education field (with scale above 3.8 out of 5). Users and observers can already assume augmented reality as an innovation in the development of IT. Respondents feel that the technology is easy to use and useful in the learning process. Respondents have also been able to enjoy the use of augmented reality in the field of education and hope that augmented reality technology can be applied in education.

Table 1
Results of AR User Acceptance

Concepts	Average
Usability	3.88
Technology Acceptance	4.31
Social Acceptance	4.08

3.3.1 Usability

The result states that the respondents as users approve that Elements 4D is easy to use with an average of 3.88 from the Likert scale. Most of the respondents strongly agree that the application makes it easier to understand chemical characteristics (50%) and chemical reactions (42%). In the application of the augmented reality learning application, respondents strongly agree to have got enough information about the name, symbol, number, and category of elements. However, users experience quite a bit of difficulty when using the application (45%) and users experience quite a few constraints when using the augmented reality application (50%).

From the user usability results, there are some interesting things. Respondents can feel the benefits and convenience in the use of application augmented reality in the education field. The use of the application is considered to be able to assist users in completing tasks. It states that the application makes it easier for them to study chemistry.

However, some respondents still experienced some problems during their use. They stated that they were still experiencing some constraints when using the application. These constraints occurred during the process of reading the element (scanning) which requires the process of downloading information first. This makes some users feel uncomfortable.

3.3.2 Technology acceptance

Most respondents strongly agree on already knowing augmented reality (58%) and already know augmented reality applications in the education field (58%) 4.31 from the Likert scale. Respondents got a very interesting experience when using application augmented reality education field (42%). Users can use the augmented reality application as a learning medium (50%) and users feel very happy when using it (58%). In addition, respondent users are willing to use application augmented reality education if its applied at school (67%).

From the results of the user's Technology Acceptance, overall users have been able to receive the development of augmented reality technology in the field of education. Respondents stated that they are willing to use the application if applied in their learning process at school. In addition, user respondents also feel happy about augmented reality technology because it provides a new experience in an interesting learning, easy and not boring.

3.3.3 Social acceptance

Most respondents felt quite awkward when they used application augmented reality (42%) with an average of 4.08 on a Likert scale. The user respondents stated that they are uncomfortable when they had to hold blocks and smartphones simultaneously (42%) so that users felt more comfortable with friends helping them to hold blocks and smartphones simultaneously (33%) Respondents were very interested when they had to interact with group colleagues to form new compounds (50%).

Most users do not feel awkward when using the augmented reality application in the education field although it will be a public concern, either from other users or others who observe it. The use of the application makes a lot of social impact on its users.

From the results stated respondents as users feel comfortable when having to interact with other users. This is proven by the results of most respondents are happy to work with group mates when using the application or sharing tasks in the work.

In addition, respondents are also willing to share information with other group users when finding new compounds.

3.4 Observer Analysis on the Application of Augmented Reality

Table 2 shows the descriptive analysis of six concepts. Overall, observers welcome the positives on the acceptance of augmented reality application in education (with scale above 3.8 out of 5). Observers can already consider augmented reality as an innovation in the development of IT. Respondent observers feel that the technology is easy to use and useful in the learning process of students. Respondents can also see users enjoy using the use of augmented reality in the field of education and hope that this technology can be applied in education.

Table 2
Results of Observers' Acceptance in Using AR

Concepts	Average
Usability	4.0
Technology Acceptance	4.12
Social Acceptance	3.8

3.4.1 Usability

Respondent observers strongly agree that the application of Elements 4D facilitates users in understanding the chemical element characteristics (60%) and makes it easy to understand the substances (80%) with an average of 4.0 of the Likert scale. Respondent observers also strongly agree that the interaction of blocks in Elements 4D facilitates the user to understand the chemical reactions of the elements. However, observers see that some users have difficulty in using the application (40%) and respondent observers see users experiencing constraints in the use of application augmented reality in education (40%).

From the usability results of observers, most observers have been able to see users feel the convenience and usefulness when they learn to use application augmented reality. Observers stated that the use of such applications facilitates users in learning chemistry. Nevertheless, most respondent observers say the same thing as users. Respondent observers see users experiencing some constraints during the process of reading elements. The obstacles made the user feel less comfortable in the learning process.

3.4.2 Technology acceptance

Respondent observers have an interesting experience when looking at the use of the Elements 4D (80%) application with an average of 4.12 from the Likert scale. Respondent observers have known the application of augmented reality in education (60%). Respondent observers stated that the Elements 4D application is very interesting (40%) and fun (40%) making it suitable to be used in student learning (80%). After observing the learning process with the application, the observer was interested in using it (80%) and the observer respondents would be willing to use the application if applied at school (80%).

From the results of Technology Acceptance of Observers, most of the observers have been able to accept the development of augmented reality technology in the field of education. This is proved by the results of respondents who stated that the use of application augmented reality in the field of education makes them interested to use the application. Respondent observers also stated that learning by using augmented reality application is becoming more interesting and fun.

3.4.3 Social acceptance

Respondents see that users simply do not seem to be in trouble when they use the application (60%) with an average of 3.8 from the Likert scale. Respondent observers do not see users feeling awkward when using application augmented reality in the education field (40%) but observers feel quite strange when seeing the user's behavior (60%).

Nevertheless, observers do not feel disturbed by the user's behavior (60%). Observers see users interacting with other users when using application augmented reality education (80%) and sharing information when they find new compounds (80%).

From the results of Social Acceptance of observers, most observers say that they do not see the awkwardness of the user in the use of application augmented reality education field. However, most observers say it still feels strange to see user behavior when using the augmented reality application. This indicates that the use of augmented reality technology in the field of education still requires social adaptation.

3.5 Recap Acceptance Analysis

3.5.1 The use of augmented reality application

Overall, both users and observers welcomed the positives of augmented reality application in education (with scale above 3.8 out of 5). However, the results of this study are still smaller than previous studies conducted by Rasimah et al. 2011 on the evaluation of mixed reality acceptance in education with a score above 4.27 out of 5. Out of the 3 categories of user acceptance, usability results have a low average value below 4 (Agree) that is equal to 3.88. It is stated that the user suffered numbers of obstacles in using the application. The results of the questionnaire stated that users experience constraints in reading the interactive blocks because of the process of downloading information made the scanning process to be very long.

Meanwhile, the results of acceptance of observers decreased the average value compared to the results of user acceptance. The results from the respondent observers acceptance got average value under 4 (Agree) that is at Social Acceptance of 3.8. Observers said that some users were still experiencing difficulties when using augmented reality application. Nevertheless, observers claim that the application of augmented reality in the education field is very useful. The results of user acceptance and observers can be seen in Table 3.

Table 3
Results of AR Usage Acceptance

Concepts	Average Users	Average Observers
Usability	3.88	4.0
Technology Acceptance	4.31	4.12
Social Acceptance	4.08	3.8

From the results user and observer acceptance, usability and social acceptance have a low rating, respondents stated that the use of augmented reality in the field of education is still experiencing some obstacles. Some observers claim that they still feel strange and awkward about the use of augmented reality in the field of education. Problems of using the application will be observed further through the results of observational video recording.

3.5.2 Video observation of the use of AR

Overall, each respondent in the observation group felt a new experience while learning through an augmented reality media. This new experience allows user respondents to experience an exciting, interactive and non-moderate learning.

Fig. 3. Interview with AR user

From the results of the questionnaire and the results of video recording, there are some similarities of problems in usability and social acceptance. From the user usability standpoint, problems were experienced in the scanning process. The first reading of each interactive block requires an internet connection. This problem was answered in the video recording result, in the first video on Problems on the Use of Augmented Reality Application. Respondents felt uncomfortable about it. While the issue of Social Acceptance of observers is answered from the results of video interview recording conducted. Observers said they felt the awkwardness and strangeness when saw augmented reality application at the first time. But as time passes, observers got used to it. Despite that, user and observer respondents said that the use of augmented reality in the education field has a more positive effect and highly recommended it to be applied to secondary educations in Indonesia.

4. Conclusion

In this research, it can be concluded that both users and observers welcomed the development of augmented reality technology in education (with scale above 3.8 out of 5). Respondents can already assume augmented reality as an innovation of IT. The results of the acceptance value of user on augmented reality in the education field; Usability = 3.88, Technology Acceptance = 4.31, and Social Acceptance = 4.08. The results of acceptance value of observer on augmented reality in the education field; Usability = 4.0, Technology Acceptance = 4.12, and Social Acceptance = 3.80. The

results of the use of AR video and interview video stated that the use of augmented reality in the field of education has a more positive effect and highly recommended it to be applied to secondary education in Indonesia.

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