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THE USE OF AUGMENTED REALITY BLENDED LEARNING FOR IMPROVING UNDERSTANDING OF FOOD SECURITY IN UNIVERSITAS SULTAN AGENG TIRTAYASA: A CASE STUDY

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ABSTRACT

The purpose of this study was to increase students' understanding of the food security concept. The experimental method was being applied in this research. Moreover, research subjects were divided into two groups, one as an experimental group and another as a control group. The subjects of this study were 100 students at the Universitas Sultan Ageng Tirtayasa. Fifty students are guided under Augmented Reality based blended learning system as the experimental group. Another class of 50 students is on the control group, which studies with the conventional blended learning approach. The experimental class obtained 73% of the N-gain result, while control class obtained 50%. Therefore, it can be concluded that using augmented reality can improve the students' understanding of the food security concept.

Keywords: blended learning; augmented reality; understanding the food security concept

INTRODUCTION

This present, the Indonesian government focuses more on food security research. The Indonesian government continues to overcome the problem of food needs and increasing national food security. One of the government's efforts is to optimize the role and function of educational institutions to carry out transformation in society (Laforge & McLachlan, 2018). Transformation is done by utilizing a variety of learning situations and various approaches to learning about understanding food security so that they have high electability in creating a generation of intellectuals who are intelligent, creative, productive, and independent (Theobald et al., 2018).

Food security means a condition that all people are available to afford food for their households (Acevedo et al., 2018). Moreover, food security can be defined as a situation where at all times has sufficient amount of safe and nutritious food for a healthy and active life (Briones et al., 2018). In general, food security is a guarantee that the food and nutrition needs of each population are the main requirements in achieving an adequate degree of health and well-being (Babu & Debnath, 2019).

Production and supply are the input aspect of the narrow food security concept (Laforge & McLachlan, 2018). Yet it cannot warrant that all the people are released from lacking food and malnutrition although food availability is abundant and exceeding the population's food needs (Acevedo et al., 2018; Hossain et al., 2019). Moreover, the human welfare is the main purpose of food security (Bonatti et al., 2018; Toulmin, 2015).

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Universitas Sultan Ageng Tirtayasa as the Center of Excellence in Food Security in Indonesia has developed a food security based curriculum or hereinafter referred to as a food security curriculum (Sjaifuddin et al., 2019). It is important to be dynamic and responsive, to serve the diversity of students, to expand learning facilities, and to educate assessment inherent in learning (Hossain et al, 2019). Also, it must be understood the reality of students as creatures who have high curiosity, like collaborative work, imaginative, creative and innovative, open, and have task-switching capabilities (Rohayani, 2015; Gupta et al., 2015). In developing curriculum and learning, lecturers can no longer avoid the reality of different student learning modalities(Bonatti et al., 2018). Lecturers must be competent to serve learning according to student needs, make digital learning materials, provide large data, and design information technology-based learning (Suryawanshia & Narkhedeb, 2015). Likewise learning services, in addition to paying attention to the learning and customization modalities, learning must also provide agility, and learning services anytime and anywhere (Sládek et al, 2011). Meanwhile, university students currently only have textbooks to learn about food security. They also are rarely given a chance to be more engaged in the learning activity by having deeper discussions with peers or lecturer. It will be beneficial if the students can apply their knowledge while the lecturer does not only focus on the material in the book.

Entering the disruptive era, learning innovation continues to be carried out by incorporating technology in the educational system so that students get richer learning information and be interactive in the learning (Buhl & Andreasen, 2018; Hmedna et al., 2019; Knox, 2016). As advances in computer and multimedia technology have evolved, technology-based learning cannot be negligible and has an important role in the learning process (Fratiwi et al, 2018; Subali et, 2017). The education system continues to develop from those who only use conventional systems to switch to digital systems (van Laar et al., 2019; Ming et al., 2014). Initially, the teaching and learning process only occurred in the classroom, but now the teaching and learning process is not bound by space and time (Knox, 2016). Lecturers must be able to provide optimal learning by using various learning models that are tailored to the characteristics of students (Hardman, 2019).

The learning model is a method that can be used to create a long-term learning plan, design learning materials and direct learning in the classroom or others (Coiduras et al.,2020; He at al., 2019). The learning model is a conceptual framework that describes a systematic procedure in organizing learning experiences to achieve certain learning goals and serves as a guide for learning designers and instructors in planning teaching and learning activities (Brew & Saunders, 2020; Hardman, 2019; Hoi, 2020; Maity et al., 2015). Blended is a learning model that mixing reality or direct learning and communication technology-based (Cheung & Wang, 2019; Hubackova & Semradova, 2016; Stockwell et al, 2015).

Moreover, blended learning model combines the advantages of learning both direct and virtually (Clement et al., 2016). It combines the conventional and modern learning (Borba et al., 2016; Morton et al., 2016). Blended Learning mixes online and face-to-face activity into an integrated learning activity (Han & Ellis, 2019). Blended Learning also means the use of a variety of methods that combine direct face-to-face meetings in traditional classes and online teaching to get the objectivity of learning (Klentien & Wannasawade, 2016).

Blended learning can be developed with various strategies according to the needs of educators and students (Vanslambrouck et al., 2019). There are five main points to build up blended learning (Shu & Gu, 2018; Te Pas et al, 2015; Vanslambrouck et al, 2018). First, Live Event, means direct learning which happens in the same time and place or at the same time but distinct place; second, Self-Paced learning which enable learners to study anytime and everywhere by using diverse learning materials intended for independent text-based and multimedia-based learning, for example: video, animation, simulation, drawing, audio, or a combination of all of them. These learning materials can be submitted online; third, Collaboration, which emphasizes on the learning participants collaboration, both of which can be cross-school; next, Assessment, which combining the type of assessment to get more valid like projects, products, etc.; the last, Performance Support Materials which are an important part. Before arranging direct learning in class and virtual face-to-face, the resources are supported and well prepared (Krasnova & Demeshko, 2015). Learning materials should be set in digital form, whether it can be accessed both offline and online (Prasad et al., 2018). Furthermore, make certain if the system application of the Learning Content Management System (LCMS has been installed well so it can run duly (Hubackova & Semradova, 2016).

From the definition of blended learning proposed by the experts above, it can be concluded that blended learning model features the combination of the conventional method with e-Learning methods. So blended learning is the slice between face to face learning and e-learning. If the diagram is illustrated, it looks like Figure 1 below.

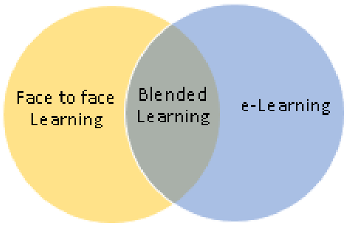

Figure 1. The Blended Learning Concept

In Figure 1, it is explained that blended learnIn Figure 1, it is explained that blended learning is the best solution for learning from class transition to e-learning (Han & Ellis, 2019). Blended learning involves classes (or face to face) and online learning (Miyazoe & Anderson, 2010). This method is very effective for increasing efficiency for instruction classes and allows for increased discussion or review of information outside the classroom (Nazarenko, 2015).

Blended learning facilitates learning that blends various methods of delivery, teaching, and learning; it also provides a large range of communication media choices for facilitators and people who are taught (Matukhin & Zhitkova, 2015). Blended learning combines face-to-face and online teaching, but more as a part of social interaction (Clement et al., 2016).

Meanwhile, the significant growth of technology offers more efficient learning process such as prompt feedback and direction in actual world learning activities (Pujiastuti & Fitriah, 2019). Based on experts, various interactive technologies can be used to various learning activities, corresponding with technological features and the learning purpose (Bettencourt et al., 2011). Accordingly, Augmented Reality becomes favorable technology for students to do assignment with the support of digital systems (Bujak et al., 2013; O'Bannon et al., 2015).

Augmented Reality is a technology that displays data over real images or live images, to modify, place or enrich actual life images, or enhance elements of the real world by displaying data (Iftene & Trandabăt, 2018). The main characteristic of Augmented Reality technology is mixing images from virtual real world (Sonntag et al., 2019). Augmented Reality technology is a technology that complements, strengthens or adds to the real world with virtual content, but does not replace it completely (Cao & Cerfolio, 2019). In conclusion, Augmented Reality is an image or video that is added or placed above the real world (O'Bannon et al., 2015).

There are three primary factors of Augmented Reality. They are virtual objects combined with substantive objects, simultaneous interactive information, and 3D presentations (Mendívil et al., 2015; Salinas & Pulido, 2015). There are two methods of identification of Augmented Reality, marker-based Augmented Reality and marker-less Augmented Reality (Bacca et al., 2015). The first (marker-based Augmented Reality) means that users need to use a cellular device to scan Augmented Reality-codes that are marked to obtain virtual information, while the second (marker-less-Augmented Reality) means that the mobile device will provide the appropriate virtual information based on the user's location through the mobile device's Global Positioning System (GPS) function(Mehta et al, 2018).

Furthermore, Augmented Reality is divided into location-based Augmented Reality and image-based Augmented Reality (Iftene & Trandabăt, 2018; Mikhail et al., 2019). The first (location-based Augmented Reality) is the same as marker-less Augmented Reality, that through the GPS function of a cellular device, the user's location can be discovered with virtual information provided according to user's location (Crofton et al, 2019). By using this application, the students will be easier to get exact location and other detail information regarding the location (Taufiq et al., 2016). Location-based Augmented Reality is different from other technology-rich environments, because: (a) uses cellular and location-based interfaces, (b) combines physical and digital space, thus creating mixed spaces, (c) extending activities outside the boundaries of traditional digital spaces (into physical space, and (d) produce rich interactions, especially interactions with the physical world and with the virtual elements they add (Sorko & Brunnhofer, 2019). Instead, Augmented Reality is based on images, the appearance of images on paper and actual image recognition (Quandt et al, 2018; Quandt et al, 2018). Augmented Reality has become a new technology that is used mostly in learning (Ibáñez & Delgado-Kloos, 2018; Salim & Hamdani, 2013). The use of Augmented Reality can be used to provide additional material before the practice class (Yip et al., 2019a).

However, this research is limited by the scope of the research, namely only students of Universitas Sultan Ageng Tirtasaya at the initial level of 2019. The next limitation is that the material used is only about food security courses. Besides, another limitation is the use of augmented reality learning media as a tool to improve the food security concept understanding. Understanding is something that we understand and we understand correctly (Robinson et al, 2018). Understanding is an attitude about how a person maintains, distinguishes, guesses, explains, expands, concludes, generalizes, gives examples, rewrites, and estimates (Robinson et al., 2018). Understanding is the ability of a person to know or understand something after it is known or remembered; covers the ability to capture the meaning of the material learned, which is expressed by describing the main contents of reading, or changing the data presented in a certain form to another form (Robinson et al., 2018). In this case, students are required to understand or understand what is taught, know what is being communicated, and can use its contents without having to connect with other things (Sincer et al, 2019).

Understanding ability can be translated into several categories including (Solomon & Croft, 2015; Stalvey et al., 2019): a) Translating, the first activity in the level of understanding is the ability to translate. This ability is related to all abilities in translating abstracts into a symbolic model so that it is easier for students to learn (Lee et al, 2019). There are several abilities in the process of translating including (Robinson et al., 2018; Tsai, 2019): 1) Translating an abstract to another abstract. 2) Translating a symbolic form to one other form/vice versa. 3) Translation from one form of words to another. b) Interpreting, this ability is broader than translating. Interpreting is the ability to recognize and understand the main idea of communication (Stalvey et al., 2019; Lee et al., 2019). There are several abilities in the process of interpreting, including 1) Ability to understand and interpret various readings in and clearly. 2) The ability to distinguish justification or denial of a conclusion described by data. 3) The ability to interpret various social data. 4) The ability to make boundaries that are appropriate when interpreting data. c) Extrapolating, the ability to understand this type of extrapolation demands higher intellectual abilities, such as making a study of what might apply(Steinberger, 2020). Some abilities in the extrapolation process include 1) Ability to draw conclusions from an explicit statement. 2) Ability to draw conclusions and state effectively (regarding the boundaries of the data, formulating conclusions that are accurate and maintaining hypotheses). 3) Ability to insert one data in a data set seen from its tendency. 4) Ability to estimate the consequences and forms of communication described. 5) Ability to be sensitive to factors that can make predictions inaccurate. 6) The ability to distinguish the type of value of consideration and a prediction(de Lange et al, 2019).

So it can be concluded that understanding is a process of understanding concepts based on their prior knowledge, connecting the recent information with existing knowledge or integrating new knowledge with existing schemes in students' thinking and the results can explain or define and interpret information with the possibility related ones using their own words. In other words, understanding is understanding something and being able to see it from various aspects (Solomon & Croft, 2015; Lee et al., 2019). Someone learners are said to understand is to understand something if he can provide a more detailed explanation or description of it by using his own words (Knuth et al., 2019; Zaslavsky, 2019). The purpose of this study is to improve understanding of the food security concept.

METHODS

Experimental methodwas applied in this research. Using this method, the research subjects were divided into two groups, one as the experimental group and the other as the control group. The subjects of this study were 100 students from Universitas Sultan Ageng Tirtayasa from two classes. There are 50 students of the experimental group that were chosen randomly and guided under Augmented Reality based blended learning system. While the rest who was being the control group studied with conventional blended learning approaches. The students in both groups were ordered to make a small team of two to three students. The effect of the experimental treatment was calculated through the N-gain difference (posttest score-pretest score) of the experimental group and the N-gain control group. N-gain according to the formulated as follows (Hake, 1998 in Apriyani 2013):

$$N-gain = \frac{S_{Post} - S_{Pre}}{S_{Max} - S_{Pre}}$$

Information:

S_{post} = Score posttest
S_{pre} = Score pretest
S_{max} = Score Maximum

The equation 1 is individual N-gain and the average N-gain is took into account by dividing the number of N-gain of each individual with the number of individuals. The interpretation of N-gain is presented in Table 1.

Table 1. Interpretation of N-gain Values

Score N-gain	Classification
g ≥ 0,7	High
0,7 ≤ g ≤0,3	Is being
g < 0,3	Low

Source: (Hake, 1998 in Apriyani 2013)

Following the research method used in the study, the design used in this study is the Randomized Control Group Pretest-Posttest Design, with the research process flow carried out can be seen in Figure 2 below (Tranchant et al., 2019).

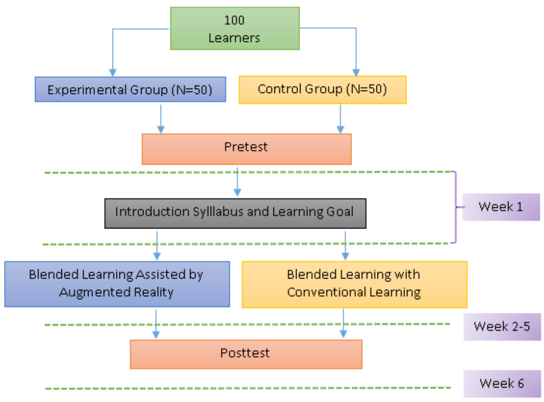

Figure 2. Quasi Experiment Design

At the beginning of the experiment, students were ordered to make up a small science project concerning the application of permaculture to evaluate their implementation competencies before learning activities. They also took initial tests to evaluate their basic knowledge about the food security concept.

During the learning activities, all students participated in the blended learning class. They watched pre-class videos and complete the worksheet at home. Hence, students in the experimental group learned with an Augmented Reality operation guidance system and class discussion. On the other hand, students in the control group wereinstructed by lecturers to complete science projects, worksheets and class discussions. The students were given time to finish their tasks in 210 minutes of 2 weeks. The material used in both groups was the same including images and videos. Furthermore, the learning content taught by lecturers was the same as the content in the Augmented Reality guide system.

RESULTS AND DISCUSSION

Understanding the concept of students has always been an essential part of the goal of science education. Science concept that needs to be understood in this case is the food security concept. Food science is integrated with biological, chemical, physical and mathematical sciences. Studying and investigating how we know something is a method of study that is still carried out to this day. Understanding of concepts is one indicator to answer one of the fundamental questions and is at the heart of the debate in the education sector mentioned earlier in the Introduction in this article. Understanding of concepts cannot be measured directly, but only interpretations of the results of tests conducted by the subject of the study. One marker of the success of an intervention (learning, program, etc.) that develops the field of educational research is N-gain as an indicator of the dynamics of understanding students' concepts of the food security concept.

The following are data obtained from the results of research and then analyzed using data processing techniques as described above. Comparison of the average N-gain of the control and experimental groups in the food security concept can be seen in Figure 3 below.

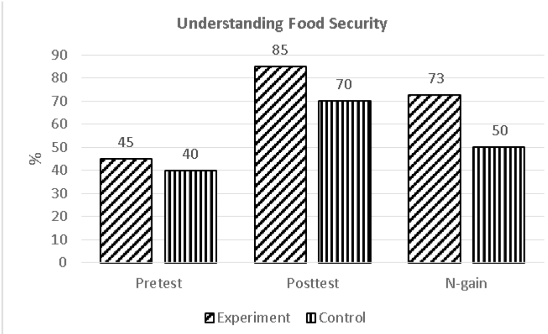

Figure 3. Comparison of N-gain Experimental Groups and Controls on the Food Security Concept

In Figure 3 above, it shows that the average for the experimental group is in the high classification, while the average gain for the control group is in the middle classification, thus the average gain of the experimental group is higher than the average gain of the control group. This shows that the use of blended learning assisted by augmented reality can further enhance food security comprehension compared to the conventional use of blended learning.

Based on the results of the study it can be said that the use of blended learning can fulfill the information and communication technology challenges in the education field. Blended learning can bridge the gap between lecturers and students during the learning process. Besides, blended learning can bring learning that is more open to anyone, free, and flexible in time.

Educational technology in the teaching and learning process, in this case, the blended learning model has changed the way students learn to adopt learning well (Wrigley et al., 2018), from model curricula to learning media based on technology (Makaramani, 2015). Learning media technology always develops in accordance with the development of information technology and the needs of learners in obtaining information (Fayomi et al., 2019). Furthermore, in line with the widespread use of Android among lecturers and students, learning technology has developed towards Android-based media that can be used by students to study in class and outside the classroom (Li & Moore, 2018).

Furthermore, understanding students' concepts for each indicator of understanding concepts can be seen in Figure 4.

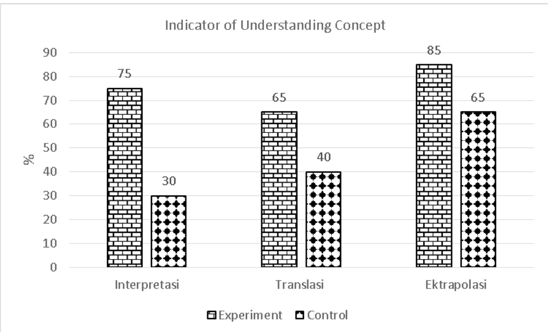

Figure 4. Indicator of Understanding the Food Security Concept

Figure 4 explains about the increase of students' understanding about concepts per indicator of understanding in the experimental class and the control class. Based on the percentage data of increasing understanding of concepts on each understanding indicator, it appears that extrapolation indicator is the dominant high category in the experimental class. This shows that students have the skills to predict the continuation of existing trends from certain data by expressing the consequences, consequences, implications, etc., in line with the conditions described in the original condition to understand the food security concept with augmented reality media assistance more quickly because learning with augmented reality leads students to practice practically and independently, also to link the food security concept in their daily lives.

In the control class, there was no improvement in the understanding of students 'concepts that were dominant in certain indicators, only in the extrapolation indicator the percentage of students' understanding of conceptual understanding reached 65%. This shows that students can predict what lecturers convey through conventional methods; this increase is much lower than in the experimental class.

Interpretation

Improved understanding of students' concepts based on interpretation indicators showed that 75% of students reached the high category for the experimental class, while the control class is 30%. This showed an increase in the ability of students to understand ideas that are recorded, changed, or arranged in other forms, such as graphics, tables, diagrams, and so on influenced by the right learning namely augmented reality.

Through augmented reality learning, all lecturer explanations can be understood and remembered by students. Thus they are capable to record the concepts they learned through experiments, whether in the form of animation or group learning. This is under the demands of augmented reality, namely learning by involving tools and the surrounding media to solve problems through experiments with animation or video, thus learning becomes effective because students can actively learn on their own. It can also be said that augmented reality learning media is a supporting factor to enrich the experience and motivate students to conduct experiments interactively and develop experimental skills activities. Augmented reality can be defined as a series of computer programs that can visualize abstract or complex phenomena carried out in the field, to improve learning activities to develop the skills needed in problem-solving.

Translation

Improved understanding of concepts based on translation indicators, namely the ability to understand an idea expressed in another way from a previously known original statement, increased understanding of student concepts in the translation indicator in the experimental class reaches 65% compared to the control class 40%. Learning with augmented reality makes students able to comprehend the concepts learned and associate with the real-life application about the food security concept. It can be said that augmented reality is as effective as working in the field, both in terms of student achievement in groups or students' capability to acknowledge the food security concept.

Extrapolation

Based on the results of data analysis, increasing the understanding of students' concepts on extrapolation indicators is the skill to predict the continuity of existing trends from certain data by expressing the consequences, implications, etc., in line with the conditions described in the original conditions. Experiments class is in the higher category than the control class which only reached 65%. This shows that students from experimental class have the ability to predict the concepts they have learned through augmented reality learning.

The different increase in concepts understanding on extrapolation indicators in the experimental class with the control class is influenced by augmented reality learning. Experimental class students can interpret lecturers' explanations and express the consequences, as well as the application of the food security concept in everyday life. Overall the ability to understand the food security concept in experimental class students is better than control class students who get conventional learning. This is indicated by the differences in the acquisition of N-gain from the two classes. Increased understanding of student concepts is due to learning with augmented reality media. Learning with a practicum in the form of animation and video is more quickly understood by students on the concepts taught by lecturers because it directly proves the findings in front of the class following the material being taught. Augmented Reality can be one of the solutions for practicum, but in virtual form (Gunawan et al., 2017; Syawaludin et al., 2019).

The results of other studies convey that the use of Augmented Reality in the learning process is an effort made to correlate learning with current developing technologies (Klimova et al., 2018). One example of the use of Augmented Reality technology in learning is Augmented Reality to study body anatomy (Jamali et al., 2015). Through Augmented Reality-based applications, students can learn about human organs, for example, the human skull in a three-dimensional form virtually and interact with these virtual objects (Kuki et al., 2011). Furthermore, by using Augmented Reality a student can learn visually and interactively about the earth and space and various underwater life (Lindner et al., 2019).

The results of this study are certainly the novelty of what is already there. During this time, the development of Augmented Reality technology is not only applied to education (Cabero et al., 2019; Jeřábek, et al., 2014), but also developed in clinical care. The results reveal that with the use of Augmented Reality technology, doctors are assisted in the operation (Huang et al., 2018; Carlson & Gagnon, 2017; McCarthy & Uppot, 2019; Mikhail et al., 2019). Augmented-Reality technology innovation forms a new environment where physical and virtual objects are integrated at different levels (Flavián et al., 2019; Ibáñez & Delgado-Kloos, 2018). Augmented reality can also be used in the welding industry like education and training. The results showed that participants who took part in the training could first practice welding techniques through Augmented Reality technology (Quandt et al., 2018; Bacca et al., 2015; Okimoto et al., 2015; Antonelli & Astanin, 2015). Augmented reality is a teaching aid that can be used during the learning process. The results show that the use of Augmented Reality as a teaching aid can help students understand the concepts taught (Jeřábek et al., 2015). Other results indicate to college students that digital literacy can be improved through the use of Augmented Reality (Coimbra et al., 2015). On the other hand, the learning of space earth science can be better understood by using Augmented Reality technology. The results show that the earth and moon circulatory system look as real as if we were in space (Lindner et al., 2019). So from this research, it can be said that the use of Augmented Reality can be an alternative learning media in higher education.

CONCLUSION

Based on the results of the research, the researcher can conclude that learning by using augmented reality can improve the understanding of the food security concept for students at Universitas Sultan Ageng Tirtayasa. This can be seen from the acquisition of the N-Gain category percentage that the experimental class is higher than the control class. Improved understanding of the concept of student food security in the experimental class in terms of indicators of understanding, showed that the extrapolation aspect experienced the highest increase.

Besides, the learning system uses augmented reality technology as a teaching aid that is represented in a virtual 3D form which is packaged in the form of modules as a learning media or creative, innovative teaching aids that can increase student enthusiasm in learning the food security concept. Augmented Reality (AR) technology is implemented properly on Personal Computers (PCs), Laptops, and Notebooks, using a camera (webcam) as a marker image capture (Marker). Testing of Augmented Reality technology in the real world environment with cyberspace objects, on the food security concept, has been successfully carried out, and that this application can be used as a new learning method or as a complement and support for the old method of teaching and learning of food security concept. This shows that the application of the food security concept learning system using Augmented Reality (AR) has satisfied the user and the appearance of the application was successfully designed well. The research conclusion is presented briefly, narrative and conceptual which describes the research findings and its impacts. Please avoid using bullets.

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