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World Geography With Augmented Reality

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Abstract – Mobile technologies enable individuals to organize and manage their daily lives through the mobile applications that are used during the day. Augmented reality is one of those applications that can be used on mobile devices. Expectations for the use of new technologies in educational environments increase in parallel with the technological advancements. Thanks to advances in computer, internet and mobile technologies, numerous new applications have emerged that facilitate communication and interaction in educational environments. In particular, the applications of the augmented reality technologies emerging with the advancing technology in the field of education are becoming widespread and easy-to-use. Augmented reality is a technology that enriches the learning process, created by real-time integration of the virtual elements and the real world elements. In geography teaching, different knowledge and skills are expected to be acquired by the learner, therefore augmented reality applications appealing to the different senses of learners can be utilized. AR technology can be used in various fields, especially in education. In addition to increasing productivity, mobile augmented reality applications would be used for multiple purposes in the field of education with the interactive facilities they offer to user such as 2D and 3D visual support and video playback.

Keywords – Augmented Reality, World Geography, Mobile Devices, Android.

I. INTRODUCTION

Technological advancements have enabled also the development of devices that have compliance to developing technology. With these new technology devices, information sharing has increased while internet usage becoming widespread. As a result of that people enable to easily access all sort of information, the processes and transactions have become even faster. At this point, augmented reality and virtual reality technology, which are innovative technologies allowing the creation of three-dimensional images and virtual environments, have begun to evolved. The technologies of augmented reality and virtual reality has many benefits intrinsic to each field, such as providing a sense of reality in a virtual environment, creating alternate experiences, providing information and convenience. Therefore, augmented reality and virtual reality technology is also used in the field of geography, in addition to various fields such as education, engineering, medicine, marketing, planning, management, advertising, PR, food and beverage, entertainment, art, museology, architecture, military fields and etc.[1].

In recent years, virtual reality (VR) and augmented reality (AR) have attracted the attention of investors as well as the society [2], [3]. Many companies are heavily investing in VR and AR nowadays [2], [4].

Whereas there are hundreds of articles on VR used in researches for the last 20-30 years, AR has a more recent application history. AR has features that support learning, such as enhancing content understanding and preservation of memory, besides the motivation to learn. On the other hand, AR is still emerging in scientific studies, even though VR benefits from open and more precise application and research areas [3].

While AR is a technology developed to create a next-generation reality-based interface, today it is moving from laboratories throughout the world to a variety of industries and consumer markets. Augmented reality supports the real world with virtual (computer-generated) objects that exist in the same place as the real world [5], [6].

Having looked at VR and AR developments chronologically, the first 3D immersive simulator can be seen in 1962 when Heilig created Sensorama, a simulated experience of a running motorcycle in Brooklyn, that is characterized by a variety of sensory impressions such as sound, olfactory, and tactile stimuli [7]. VR was introduced as a training tool for an airline company and air force in the early ‘90s [6], [8], [9].

Augmented reality is the live, direct or indirect physical view of the real-world environment and its contents created by enriching computer-generated sound, images, graphics and GPS data. This concept, in brief, is alteration, enrichment, and augmentation the reality by the computer. Technology functions to enrich reality for people. In virtual reality, on the other hand, there is a world designed and animated instead of the real world, which differs from augmented reality [8]. Augmented reality (AR) can be defined as a technology that places virtual objects (augmented components) in the real world. These virtual objects then appear to co-exist in the same space together with real-world objects [10], [11].

Being a focus of interest in recent years, AR is a technology that has become widespread in educational environments. One of the main reasons why AR become a widely utilized technology is that it no longer requires complex and highly sophisticated equipment with expensive hardware so that it can be used with computers or mobile devices. Therefore, AR technology does not have as a narrow range of uses as it was in the past. Today, it can be used at all levels of education, from primary level to university [8], [12], [13], [14].

Although AR is a new technology, it is used in many areas such as architecture [15], maintenance [16], entertainment [17], education [12], [18], [19], medicine [20].

A lot of research has been conducted on AR in recent years. In a study, the studies on AR from the past to the present were examined. Results of the analysis made by the publication dates revealed that the number of studies has increased steadily since 2007. It is stated that 50% of the research was conducted with primary school students while 30% including university students.

The reasons why the studies were mostly conducted with primary school students can be explained by Piaget's cognitive development stages. These students use their visual and auditory senses further since they are in a concrete operational stage [21]. Children spend a lot of time with playing digital games, and according to the researchers, utilizing the AR games is suitable to engage young students in learning [8], [12].

There are many literature reviews in the fields of global education and technology. In these studies, researchers focus on the topics such as e-learning, mobile and ubiquitous learning, blended learning, and educational technologies [12].

Researchers consider that augmented reality technology has possible major contributions in terms of teaching and learning. According to Yuen [22], the fields that augmented reality contributes are as follows:

a) Stimulating and motivating students to explore classroom materials from different aspects,

b) Helping students learn subjects which they may not gain firsthand experience regarding the real world,

c) Improving cooperation between students and teachers,

d) Increasing the creativity and imagination of the students,

e) Assisting students in order to control their learning at their own pace and in their own pathways,

f) Creating an authentic learning environment suitable for a variety of learning styles.

Thanks to the augmented reality glasses, many universities around the world have offered their students the chance to experience environments and practices that they have no opportunity to observe or experience in real life, to create a more effective educational environment in the departments such as medicine, engineering and architecture [22], [23].

Some of the application fields where AR technologies are benefitted for educational purposes are as follows [24], [25]:

• Adding a third dimension to two-dimensional books,

• Training on cognitive and psychomotor maintenance/repair tasks,

• Three-dimensional displaying of concepts or conducting experiments in fields like physics, chemistry, biology,

• Teaching the concept of magnetism in the field of physics,

• Demonstrating molecular structures in the field of chemistry,

• Demonstrating cells as three-dimensional in the field of biology

• Following and conducting experiments with phenomena on various subjects in science museums through videos or visuals,

• Visualizing concepts and spatial relationships in the lessons of mathematics and geometry,

• Visualizing concepts in geography education,

• Gaining experience on classroom management in teacher training.

Technology has a great significance for AR [26], which is accessible via different technologies such as tablets, PC, or HMD. Different AR technologies have different features in terms of educational environments. Cost, accessibility and usability are the major ones among these features. The most preferred AR technology is seen as mobile devices.

According to Henrysson, Billinghurst and Ollila [27], mobile devices provide an ideal platform for AR applications. Notably, it is easy to use and quite cost-effective for young learners [28]. Desktop computers can support AR applications but are not portable due to hardware limitations [29] and are not much preferred because of these limitations. On the contrary, mobile devices provide numerous advantages such as portability, encouragement of high social interaction and autonomous interoperability [30]. Furthermore, they are also beneficial for the students participating in outdoor observations and learning activities [13]. Additionally, ground-based AR on mobile devices enables students to concentrate on the learning process [29] and improves their collaboration skills [31], [32]. Since mobile devices are portable and allow students to ask on-site questions through location-based AR applications, they facilitate meaningful learning. Mobile devices are expected to gain more popularity in the future [12]. In Figure-1, an application conducted with mobile devices is given [33].

Figure 1. Augmented Reality Application

II. Material And Methods

2.1 Vuforia Software

Vuforia is a software platform utilized for creating Augmented Reality applications. Developers can easily add advanced computer vision feature to any application that enables it to recognize images and objects or reconstruct environments belonged to real-world. Having all the functionality and performance necessary to meet the users ' requirements, Vuforia offers a corporate application for providing product visualization to enable shopping experiences with its step-by-step instructions, tutorials, or an interactive marketing campaign. The addition of Universal Windows Platform (UWP) tablet support extends Vuforia OS support beyond iOS and Android. Currently, developers are targeting next generation UWP tablet devices, including Microsoft's Surface Pro 4 and Surface Book. The newest version of Vuforia includes support for OpenGL ES 3.x in addition to improvements in our Cloud Recognition service. OpenGL ES 3.x offers access to a wider range of textures and shading that you can use for creating high-end effects in your applications. Moreover, it can take advantage of improvements and power optimizations for new mobile devices. Cloud Recognition users benefit from updates designed to improve recognition speed and accuracy [34], [35], [36], [37], [38], [39].

2.2 World Geography Application Targets with Augmented Reality

The application consists of eight ImageTargets in total, with a world map and seven continents. Vuforia software was utilized for AR processes. Basic components of AR technology such as various materials, textures, sound and video were used for the application. On the other hande, C # scripts were used for object movements. This project was performed with Unity 3D 2018.4.19f1 (64 Bit) Windows version. In the project, by using the samples of assets and features of all continents, general image information on the relevant continent has been tried to be conveyed. This is a summary of all information. It carries the purpose of training the ones who use the application created to set an example for education and learning with visuals. It is thought that the project, which can be a reference study and be an example to the people aiming to develop application, will be beneficial. By performing basic processes as the content of study, the project outline was determined. Main processes were respectively applied such as creating ImageTarget, displaying

the object, using the AR camera, creating a video plug-in, audio plug-in and short scripts.

III. APPLICATIONS

Geographical features were taken into consideration during the application stages. Introductory materials were revealed by using the figure (Fig-2) in which all continents in the world are together, and the continent of Africa, Asia, Antarctica, Europe, North America, South America and Australia and the distinct objects belonging to these continents. When the images belonged to the continents in Figures 3, 5, 7, 9, 11, 13 and 15 are shown to the camera, the symbol features specific to the continent are displayed on the application screen.

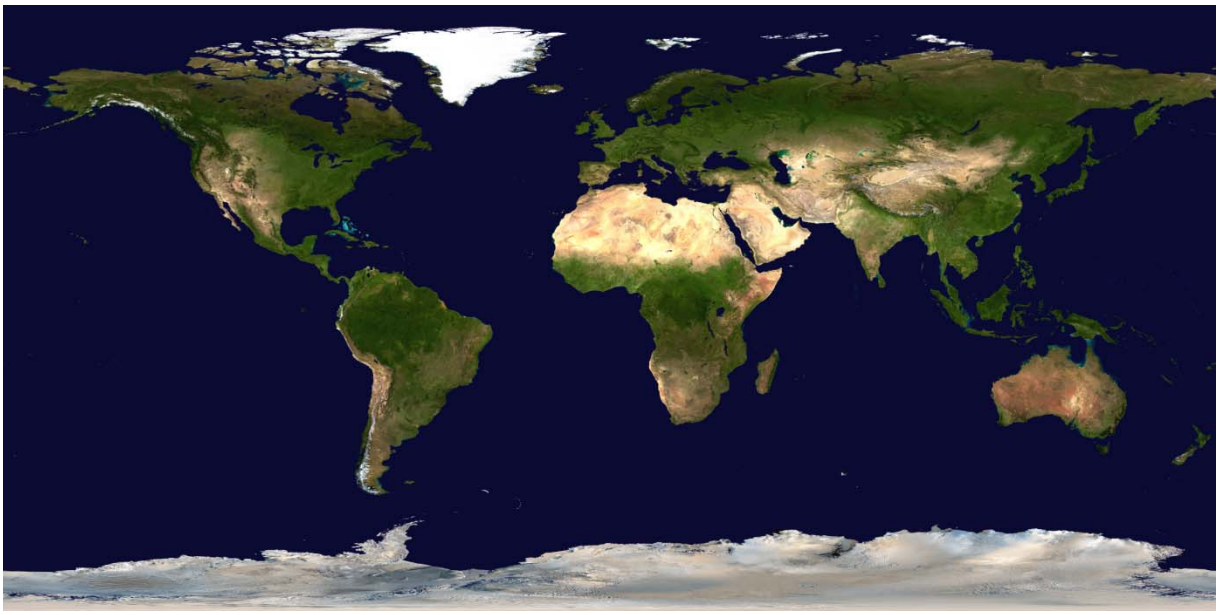

Figure 2. Equirectangular projection of world [40]

3.1.African Continent

Africa is the second largest continent in the world in terms of acreage and population density. Keops Pyramid, which is one of the 7 wonders of the world, giraffe, gazelle and lion are the most well-known items about Africa. When the African continent map (Fig.3) is viewed on the augmented reality application with mobile device, objects belonging to Africa, Cheops Pyramid, lion, giraffe, gazelle and ancient corn appear on the application screen (Fig.4).

In this way, the images that appear in the minds of primary school students, when it comes to Africa, will be imprinted in their visual memories in 3 dimensions. As a result, persistence and interpretation will be ensured in learning.

Figure 3. African continent map used in the application

Figure 4. The output of symbols unique intrinsic to the African continent

3.2. Asian Continent

Asia is the largest and also the most populous continent in the world. The Great Wall of China is the first thing that comes to mind about Asia. The Great Wall of China is a structure that extends along the Northwest of China and goes down in history as the world's largest defense walls. Its view from the space is like a long and thin river.

Taj Mahal is another unique work on the Asian Continent. The building, which is located in Agra, India and is on the UNESCO's World Heritage List, visited by millions of people every year. In addition, elephants and rhinoceros are also among the animals native to the Asian continent. When the Asian continent map (Fig.5) is viewed with the augmented reality application designed, Taj Mahal, elephant and rhino emerge in the 3D structure (Fig. 6).

Figure 5. Asian continent map used in the application

Figure 6. The output of symbols intrinsic to the Asian continent

3.3. Antarctic Continent:

98% of the Antarctic continent is covered by the ice cap. Since there is no large living space for humans, man-made elements do not come to mind when Antarctica is mentioned. Animals such as penguin, seal and blue whale are the first things come to mind when it comes to Antarctica. When looking at the Antarctic continent map (Fig.7) with the augmented reality application, the penguin, seal and blue whale can be seen as 3D (Fig.8).

Figure 7. Antarctica continent map used in application

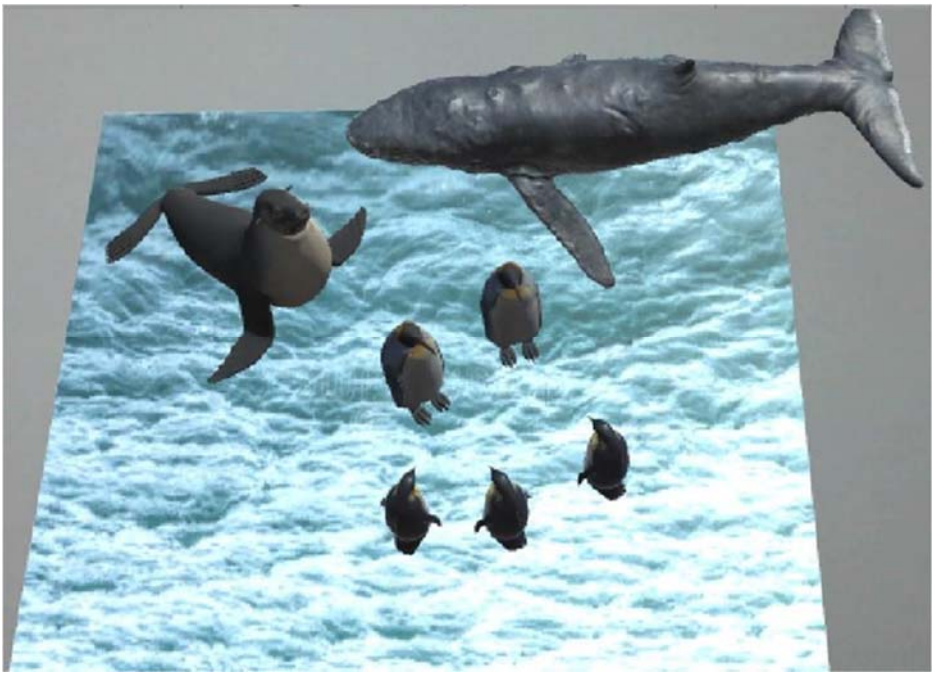

Figure 8. Output of symbols intrinsic to the Antarctic continent

3.4. European Continent Object

Europe is known as one of the oldest continents in the world. Although there have been many works and structures in Europe, some of them stand out more. Pisa Tower, Eiffel Tower, and Notre Dame Cathedral are among the ones that come to mind first. Also, the English Horse is one of the animals native to this continent. When the European continent map (Fig.9) is viewed with the application we used in the project, the most well-known elements of the European continent, the Pisa Tower, the Eiffel Tower, the Notre-dame Cathedral, and the English horse, appear as 3D (Fig.10).

Figure 9. European continent map used in application

1.1 Şekil 10. Output of symbols intrinsic to the European continent

3.5. South American Continent

The American continent is divided into two, as North America and South America. First, the objects related to the South American continent were determined for the application. The Statue of Christ in Brazil, one of the 7 wonders of the world, is the work that comes to mind first about this continent. Again, the American bison and tarantula are the first animals that come to mind, native to this continent. When the South American continent map (Fig.11) is viewed

with the augmented reality application, the Jesus Statue, American bison, and the tarantula appear in 3D structure (Fig.12).

Şekil 11. South American continent map used in the application

1.2 Figure 12. The output of symbols intrinsic to the South American continent

3.6. North American Continent

The Statue of Liberty is one of the first structures that come to mind regarding the North American continent.

Megalodon fish, American goose and swan are the animals native to the American continent. In addition, New York is among the first places that come to mind. As a result of the interaction of the application we have designed and the North American continent map (Fig.13), the Statue of Liberty, New York City, the goose, swan, and megalodon fish appear as 3D (Fig.14).

Figure 13. North American continent map used in the application

Figure 14. The output of symbols intrinsic to the North American continent

3.7. Australian Continent Object

The Australia is the smallest continent in the world. Kangaroos are the first to come to mind, when it comes to Australia. The Sydney Opera House is most well known work among the man-made items. Finally, when the Australian continent map is viewed with the augmented reality application, the Sydney opera house (Fig.15) and kangaroos (Fig.16) appear as 3D.

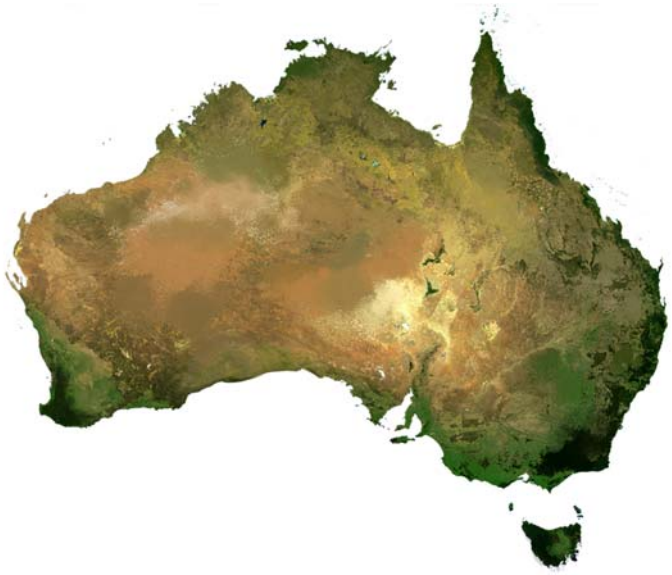

Figure 15. Australian continent map used in the application

Figure 16. The output of symbols intrinsic to the continent of Australia

IV. Conclusion And Discussion

Technological developments have created a virtual living space for humans, besides taking a place in every sphere of life. Today, virtuality leaves its place to an environment where reality and virtuality are intertwined. This technology, which we have been using through mobile devices for a while in our daily lives, is not known as Augmented Reality, although it has a large number of users. For the continuity of developments, it has great importance that people adopt the technology used and to comprehend what it is. Many studies have been conducted on the technology of Augmented Reality, in the field of both hardware and software. Portable display units such as head-mounted display units in virtual reality and tablets in augmented reality applications turn into one of the indispensable elements of today's social life, while It necessitates the use of hardware in watchable and controllable moving images. The idea of spatial augmented reality, which brings a new perspective to the use of hardware in enhancing the existing reality, was emerged. Certain limitations still exist despite all the studies, however these limitations are expected to be overcome within time. Developments in Augmented Reality technology have led to the emergence of many applications in the field of Geography, as in other fields. There are applications with different features related to the world. This study aims to examine the latest developments in the technology of Augmented Reality and to bring a new geographic perspective to them. In accordance with this purpose, the latest hardware and software developments in the field of Augmented Reality have been examined, and their reflections in the geographical field have been evaluated through examples.

References

[1] Demirezen, B. (2019). Artırılmış gerçeklik ve sanal gerçeklik teknolojisinin turizm sektöründe kullanılabilirliği üzerine bir literatür taraması. *Uluslararası Global Turizm Araştırmaları Dergisi*, *3*(1), 1-26.

[2] Castelvecchi, D. (2016). Low-cost headsets boost virtual reality's lab appeal. *Nature News*, *533*(7602), 153.

[3] Cipresso, P., Giglioli, I. A. C., Raya, M. A., & Riva, G. (2018). The past, present, and future of virtual and augmented reality research: a network and cluster analysis of the literature. *Frontiers in psychology*, *9*, 2086.

[4] Fernandez, M. (2017). Augmented virtual reality: How to improve education systems. *Higher Learning Research Communications*, *7*(1), 1-15.

[5] Höllerer, T., & Feiner, S. (2004). Mobile augmented reality. *Telegeoinformatics: Location-based computing and services*, *21*.

[6] Van Krevelen, D. W. F., & Poelman, R. (2010). A survey of augmented reality technologies, applications and limitations. *International journal of virtual reality*, *9*(2), 1-20.

[7] Gutierrez, M., Vexo, F., & Thalmann, D. (2008). *Stepping into virtual reality*. Springer Science & Business Media.

[8] Azuma, R. T. (1997). A survey of augmented reality. *Presence: Teleoperators & Virtual Environments*, *6*(4), 355-385.

[9] Lee, K. (2012). Augmented reality in education and training. *TechTrends*, *56*(2), 13-21.

[10] Bower, M., Howe, C., McCredie, N., Robinson, A., & Grover, D. (2014). Augmented Reality in education–cases, places and potentials. *Educational Media International*, *51*(1), 1-15.

[11] Azuma, R., Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. (2001). Recent advances in augmented reality. *IEEE computer graphics and applications*, *21*(6), 34-47.

[12] Akçayır, M., & Akçayır, G. (2017). Advantages and challenges associated with augmented reality for education: A systematic review of the literature. *Educational Research Review*, *20*, 1-11.

[13] Chiang, T. H., Yang, S. J., & Hwang, G.-J. (2014). Students' online interactive patterns in augmented reality-based inquiry activities. *Computers & Education, 78*, 97-108.

[14] Santos, M. E. C., Chen, A., Taketomi, T., Yamamoto, G., Miyazaki, J., & Kato, H. (2013). Augmented reality learning experiences: Survey of prototype design and evaluation. *IEEE Transactions on learning technologies*, *7*(1), 38-56.

[15] Lin, C. H., & Hsu, P. H. (2017). Integrating procedural modelling process and immersive VR environment for architectural design education. In *MATEC Web of Conferences* (Vol. 104, p. 03007). EDP Sciences.

[16] Schwald, B., & De Laval, B. (2003). An augmented reality system for training and assistance to maintenance in the industrial context.

[17] Ozbek, C. S., Giesler, B., & Dillmann, R. (2004, May). Jedi training: playful evaluation of head-mounted augmented reality display systems. In *Stereoscopic Displays and Virtual Reality Systems XI* (Vol. 5291, pp. 454-463). International Society for Optics and Photonics.

[18] Nincarean, D., Alia, M. B., Halim, N. D. A., & Rahman, M. H. A. (2013). Mobile augmented reality: The potential for education. *Procedia-social and behavioral sciences*, *103*, 657-664.

[19] Bacca Acosta, J. L., Baldiris Navarro, S. M., Fabregat Gesa, R., & Graf, S. (2014). Augmented reality trends in education: a systematic review of research and applications. *Journal of Educational Technology and Society, 2014, vol. 17, núm. 4, p. 133-149*.

[20] De Buck, S., Maes, F., Ector, J., Bogaert, J., Dymarkowski, S., Heidbuchel, H., & Suetens, P. (2005). An augmented reality system for patient-specific guidance of cardiac catheter ablation procedures. *IEEE Transactions on Medical Imaging*, *24*(11), 1512-1524.

[21] Martin, D. J., & Loomis, K. S. (2013). *Building teachers: A constructivist approach to introducing education*. Cengage Learning.

[22] Yuen, S. C. Y., Yaoyuneyong, G., & Johnson, E. (2011). Augmented reality: An overview and five directions for AR in education. *Journal of Educational Technology Development and Exchange (JETDE)*, *4*(1), 11.

[23] Bingol, B. (2018). Yeni Bir Yaşam Biçimi: Artırılmış Gerçeklik (AG). *Üsküdar Üniversitesi İletişim Fakültesi Akademik Dergisi Etkileşim*, (1), 44-55.

[24] Somyürek, S. (2014). Öğretim sürecinde z kuşağının dikkatini çekme: artırılmış gerçeklik. *Eğitim Teknolojisi Kuram ve Uygulama*, *4*(1), 63-80.

[25] Kaleci, D., Demirel, T., & Akkuş, İ. (2016). Örnek bir artırılmış gerçeklik uygulaması tasarımı. *XVIII. Akademik Bilişim Konferansı, Aydın, Türkiye*.

[26] Wu, H. K., Lee, S. W. Y., Chang, H. Y., & Liang, J. C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & education*, *62*, 41-49.

[27] Henrysson, A., Billinghurst, M., & Ollila, M. (2005, October). Face to face collaborative AR on mobile phones. In *Fourth ieee and acm international symposium on mixed and augmented reality (ismar'05)* (pp. 80-89). IEEE.

[28] Furió, D., González-Gancedo, S., Juan, M. C., Seguí, I., & Costa, M. (2013). The effects of the size and weight of a mobile device on an educational game. *Computers & Education*, *64*, 24-41.

[29] Chiang, T. H., Yang, S. J., & Hwang, G. J. (2014). Students' online interactive patterns in augmented reality-based inquiry activities. *Computers & Education*, *78*, 97-108.

[30] Hwang, G. J., Tsai, C. C., Chu, H. C., Kinshuk, K., & Chen, C. Y. (2012). A context-aware ubiquitous learning approach to conducting scientific inquiry activities in a science park. *Australasian Journal of Educational Technology*, *28*(5).

[31] Bressler, D. M., & Bodzin, A. M. (2013). A mixed methods assessment of students' flow experiences during a mobile augmented reality science game. *Journal of computer assisted learning*, *29*(6), 505-517.

[32] Yu, D., Jin, J. S., Luo, S., Lai, W., & Huang, Q. (2009). A useful visualization technique: a literature review for augmented reality and its application, limitation & future direction. *Visual information communication*, 311-337.

[33] Salmat (2018). Augment Reality. Retrieved May 18, 2020, from http://www.salmat.com.tr/tr/artirilmis-gerceklik-154

[34] Frantz, T., Jansen, B., Duerinck, J., & Vandemeulebroucke, J. (2018). Augmenting Microsoft's HoloLens with vuforia tracking for neuronavigation. *Healthcare technology letters*, *5*(5), 221-225.

[35] Linowes, J., & Babilinski, K. (2017). *Augmented reality for developers: Build practical augmented reality applications with unity, ARCore, ARKit, and Vuforia*. Packt Publishing Ltd.

[36] Peng, F., & Zhai, J. (2017). A mobile augmented reality system for exhibition hall based on Vuforia. In *2017 2nd International Conference on Image, Vision and Computing (ICIVC)* (pp. 1049-1052). IEEE.

[37] Kim, Y. G., & Kim, W. J. (2014). Implementation of augmented reality system for smartphone advertisements. *international journal of multimedia and ubiquitous engineering*, *9*(2), 385-392.

[38] Amin, D., & Govilkar, S. (2015). Comparative study of augmented reality SDKs. *International Journal on Computational Science & Applications*, *5*(1), 11-26.

[39] Vuforia Software (n.d.); Getting Started with Vuforia for Android Development. Retrieved May 4, 2020, https://library.vuforia.com/articles/Solution/Getting-Started-with-Vuforia-for-Android-Development.html

[40]Equirectangular projection of World (n.d.). In Wikipedia. Retrieved May 14, 2020. https://tr.wikipedia.org/wiki/E%C5%9Fdikd%C3%B6rtgensel_izd%C3%BC%C5%9F%C3%BCm#/media/Dosya:Blue_Marble_2002.png