Exploring the effect of materials designed with augmented reality on language learners' vocabulary learning

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Abstract

The purpose of this study was to determine the motivational level of the participants in a language classroom towards course materials designed in accordance with augmented reality technology and to identify the correlation between academic achievement and motivational level. 130 undergraduate students from a state-run university in Turkey participated in this study and Turkish version of Material Motivational Survey was used to determine the undergraduate students' motivational level about the materials which were designed with AR technology to teach English words at the elementary level. The results of this study suggested that AR technology materials had positive impact on increasing undergraduate students' motivation towards vocabulary learning in language classroom. This study also signified that a positive significant correlation was found between academic achievement and the motivation in the use of AR technology in language classroom.

Keywords: AR technology, educational technology, augmented reality, learning vocabulary in English

INTRODUCTION

Continuous development of technology causes the changes in teaching and learning practices. During this process, learners' profile may change, too. As today's generation is

called digital native, the use of technology in education makes learning more inspiring, motivating, meaningful and remarkable (Singhal et al., 2012). As Augmented Reality technology is a recent topic in the field of education, researches on this technological tool are at the beginning level. However, current practices on this issue suggest that AR technology makes learning more long lasting and effective, because, it offers 3D learning content and visualization of 3D objects from different views in comparison with traditional 2D practices (Chang et al., 2010). In addition, AR is a tool which supports learning through various channels by mean of sound, picture, writing, video and animation. These facilitative tools reduce the problems originated from individual differences and help to create an effective learning atmosphere by providing richer context particularly for oral courses based on interaction.

In the field of language education field, written and oral comprehensible input are vital for learners, because using pictures, videos, sounds and animations enrich the input and make the learning long lasting and interesting. In this respect, AR technology offers many opportunities in the field of language teaching and learning. Yang (2011) asserts that staying for a longer time in the community where the target language is spoken is the one of the most effective ways of learning a foreign language. However, time and financial limitations prevent learners to follow this way. In this case, AR technology offers this opportunity and brings the real-life objects into the language classroom and creates a feeling of authenticity. Therefore, this study aims to fill a gap and highlight some points on the use of AR technology in language teaching and learning. It is believed that the pedagogical implications of this study will make contribution to the field and add new suggestions to the current literature.

Conceptual Framework

Although the origins of augmented reality technology studies date back to 1950s, the term Augmented Reality was used by Tom Caudell for the first time. He designed a head-mounted digital visualization system to guide technicians during the location of cables on the planes (Siltanen, 2012). Milgram et al. (1994) proposed a mixed AR technology model which represented the combination of reality and virtuality. This model bore the main tenets of AR technology during the process of development (Chen & Tsai, 2012).

Milgram et al. (1994) define the augmented reality as "augmenting natural feedback to the operator with simulated cues" (p.283). According to Klopfer and Squire (2008), AR is "a situation in which a real world context is dynamically overlaid with coherent location or context sensitive virtual information" (p.205). Lee et al. (2012) maintain that AR technology can be thought as a bridge between virtual and real world.

Azuma (1997) emphasizes three important points which make AR technology different from other technological tools. These are combination of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects.

The applications designed by 3D objects not only allow pictures, writing, videos and animations to be used separately but also enable these tools to be activated simultaneously (Wang et al., 2013). Thus, users can interact with objects, events and information in natural ways (Wojciechowski & Cellary, 2013).

Based on the current literature, the educational attainments of AR technology can be summarized as follows:

Concretizing abstract concepts (Dori & Belcher, 2005), helping better understanding of the concepts/processes (Klopfer & Squire, 2008), providing opportunities for more authentic learning and appealing to multiple learning styles (Yuen, 2011), making

understanding easier by visualizing (Kaufmann & Schmalstieg, 2003), boosting engagement (Bujak et al., 2013), developing critical thinking and problem solving skills (Dunleavy, Dede & Mitchell,2009), helping students enjoy from the learning process (Núñez et al., 2008), making learning more appealing and effective (Wojciechowski & Cellary, 2013), drawing attention (Aziz et al., 2012), establishing links with real life experiences (Ternier et al., 2012), creating contextual awareness (Ivanova & Ivanov, 2011), facilitating comprehension (Ivanova&Ivanov, 2011) and increasing motivation (Di Serio et al., 2013).

REVIEW OF LITERATURE

Since the recent introduction of AR technology in education and specifically foreign language education field, the literature focused on the development, usability, and initial implementation of AR technologies (El Seyad et al., 2011). Wu et al. (2013) described these studies as relatively simple, short-term, small-sample in exploratory nature. According to Klopfer & Squire (2008), researchers mostly did design-based researches related to this technology.

With regard to the current literature on AR technology and foreign language education, few researches drew attention on the application and testing of AR technology. Di Serio et al. (2013) investigated the role of augmented reality technology in motivating middle school students for a visual art course in Spain. They introduced the lesson in two different formats as slide-based and augmented reality technology-based environment. Then, they administered the Instructional Materials Motivation Survey to participants to collect data about their motivational level. The results of the study revealed that participants rated higher the motivational factors of attention and satisfaction in an augmented-reality-based learning environment than slide-based learning environment. When factors were analyzed separately, the attention and confidence were factors which had the highest mean. Finally, this study

suggested that augmented reality technology had a positive impact on the motivation of middle-school students.

In English language learning, two remarkable AR technology tools called MOBILE and HELLO were designed to teach some topics in English (Tan & Lui, 2004; Lui et al., 2010). Tan & Lui (2004) developed a Mobile-Based Interactive Learning Environment (MOBILE) to teach body parts and creation of species in and outside classroom through mobile learning tools to improve Japanese elementary school students' English proficiency. After a process of implementation, they suggested that this technology helped to increase learners' performances in comparison with the traditional method.

Lui et al. (2010) designed a hand-held augmented reality mobile English learning system (HELLO) which learners could reach context-aware learning material wirelessly in Taiwan. Each learner followed the guide map on the phone screen to access learning zones and to decipher QR codes. This system was practiced by university students and participants expressed high-level of satisfaction upon implementation based on a survey and a case study.

Ibanez et al. (2011) investigated the role of augmented reality and augmented virtuality in learning Spanish in a virtual world. They used augmented reality and augmented virtuality to organize learning activities such as exploration, collaboration and mixed reality activities in a multiuser 3D virtual world. The results of their study suggested that using augmented reality in learning Spanish increased students' motivation and learning outcomes.

Barreira et al. (2012) studied the role augmented reality technology in teaching animal words in English to Portuguese elementary school students whose ages ranged from 7 to 9 at 3rd grade. Twenty-six children participated in this study and two groups were formed as experimental and control. Target vocabulary items were presented through matching object

game by an expert teacher. At the end of the practice, students' performances in experimental group were found higher than those of control group in accordance with the test results.

Perez-Lopez & Contero (2013) investigated the use of augmented reality in teaching digestive and circulatory systems at the primary school level, and its role on knowledge retention. The results of the study suggested that AR use in the classroom helped learners retain more concepts than they did in traditional teaching methodology. They also revealed that AR technology was a useful means to improve learners' motivation and interest and increased the learners' performance in a learning environment.

Silva et al. (2013) explored the role of Augmented Reality blocks in developing literacy skills of first graders. They used two quantitative and one qualitative metrics to evaluate the tool. The results revealed that the tool helped to increase students' educational performance and enhanced their literacy skill. Moreover, teachers' enthusiasm was very high due to its use.

Mahadzir & Phung (2013) studied Augmented Reality pop- up books to motivate and support students in English language learning. They developed a pop-up book via ZooBurst tool and it was incorporated with Keller's ARCS model of motivation. They observed primary school students using AR pop-up book for a year and conducted semi-structured interview at the end of application. They revealed that AR pop-up book contributed to "perceptual arousal, inquiry arousal, variability, goal orientation, motive matching, familiarity, learning requirements, success opportunities, personal control, intrinsic reinforcement, extrinsic rewards, and equity". In addition, it was found that AR technology increased students' performance by providing more inspiring environment for students.

METHOD

Descriptive research model was used in this study. This method helped to describe the existing situation as it was. Attitude, beliefs and views were studied via this method (McMillan & Schumacher, 2006). The purpose of this study was to determine the motivational level of the participants in a language classroom towards course materials designed in accordance with augmented reality technology and to identify the correlation between academic achievement and motivational level. The following hypothesis questions were answered in this study.

Question 1 what was the effect of materials designed with AR technology on learners' motivation?

Question 2 was there a significant difference between the use of augmented reality technology and learners' motivation in terms of gender?

Question 3 was there a significant difference between the use of augmented reality technology and learners' motivation in terms of majors?

Question 4 was there a correlation between the use of augmented reality technology and academic achievement of the learners?

Participants

130 undergraduate students (82 females, 48 males) from a state-run university in Turkey participated in this study. They can be regarded as false beginners. Macmillan Dictionary defines the term, false beginner as

someone who starts to study a language from the beginning again,

although they already have a slight knowledge of it. Participants studied English at the primary, secondary and high schools as a part of the school curriculum; however, their

English language level could be described as beginners. As a freshman, they took up mandatory English course 3 credits a week. In this course, An English course book was used and the topics previously learnt were refreshed and reminded. The main problem in this course was that English course was not a priority for them because they attended at different majors and their educational objective was to specialize at their own majors. This situation affected students' motivation negatively and made things hard for language teachers. The distribution of the majors was presented in Table 1.

Table1

Participants in terms of majors

Majors	N	%
Turkish Language Teaching	30	23,1
Computer and Instructional Technology	27	20,8
Psychological Counseling	29	22,3
Theology teaching	44	33,8
All	130	100,0

Instrument

Material Motivational Survey (Keller, 1987) was used to determine the undergraduate students' motivational level about the materials which were designed with AR technology to teach English words at the elementary level. This survey which was developed to measure the motivational level of the learners towards materials was translated into Turkish and validated by Kutu & Sozbilir (2011). They found the survey as 24 items with two factors (attention-relevance and confidence -satisfaction). Cronbach Alpha reliability was calculated 0.83 total

and for subfactors respectively from 0.79 to 0, 69. The survey was in the form of five point likert scale graded from I never agree (1) to I completely agree (5).

In this study, a material was designed supported with AR technology to introduce new vocabulary items to undergraduate students at the elementary level. Freshmen studied English three credits a week besides their specialization courses. Although they spent much time studying English at various levels of their schooling, their English level was considered as beginners. The lack of appropriate course book or language learning material which was interesting and suitable for learners' level was one of the reasons for this failure. In addition, the written form and the pronunciation of each word in English were different, which made vocabulary learning harder for language learners. In order to help learners better memorize the words, the material was designed with augmented reality technology with an animation and the pronunciation of the word embedded into the program. Via this method, the material was more interesting for learners and these tools were believed to help retain the new information in the memory for a longer period of time. This material was used for three weeks by a language teacher and the designers of the materials to present new vocabulary items to the learners. The implementation of the AR technology was presented in Figure 1.

Figure 1

The Implementation of augmented reality in the classroom

At the end of this period, the survey was administered to the learners to understand their views about the material on volunteering basis. Moreover, learners' test score was collected to analyze the correlation between academic achievement and motivational level.

Findings and Result

Table 2

Descriptive Statistics of all items based on participants' responses

Items		M	S.D
1.	There was something interesting at the beginning of this lesson that got my attention.	3,80	1,01
2.	These materials are eye-catching.	4,12	,98
3.	This lesson is so abstract that it was hard to keep my attention on it.	1,94	1,17
4.	The way the information is arranged on the pages helped keep my attention.	4,07	1,01
5.	This lesson has things that stimulated my curiosity.	4,03	1,02
6.	I learned some things that were surprising or unexpected.	3,61	1,21
7.	The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the lesson.	3,99	1,19
8.	There were stories, pictures, or examples that showed me how this material could be important to some people.	4,00	1,20
9.	The content of this material is relevant to my interests.	4,06	1,05
10.	There are explanations or examples of how people use the knowledge in this lesson.	3,60	1,26
11.	The content and style of writing in this lesson convey the impression that its content is worth knowing.	4,10	,96
12.	This material was more difficult to understand than I would like for it to be.	1,32	,77
13.	After reading the introductory information, I felt confident that I knew what I was supposed to learn from this lesson.	3,66	1,05

14. I could not really understand quite a bit of the material in this lesson.	1,67	1,01
15. Completing the exercises in this lesson gave me a satisfying feeling of accomplishment.	3,38	1,29
16. The exercises in this lesson were too difficult.	1,43	,89
17. After working on this lesson for awhile, I was confident that I would be able to pass a test on it.	3,91	1,12
18. I could not really understand quite a bit of the material in this lesson.	1,82	1,21
19. The good organization of the content helped me be confident that I would learn this material.	3,83	,98
20. Completing the exercises in this lesson gave me a satisfying feeling of accomplishment.	3,91	1,11
21. I enjoyed this lesson so much that I would like to know more about this topic.	3,83	1,16
22. It was a pleasure to work on such a well-designed lesson.	3,83	1,17
23. The wording of feedback after the exercises, or of other comments in this lesson, helped me feel rewarded for my effort.	3,68	1,16
24. It felt good to successfully complete this lesson.	4,02	1,18

According to the results of the descriptive statistics of all items in the survey, item 2 saying “These materials are eye-catching” had the highest mean (M=4.12, SD=0, 98). Next highest mean belonged to the item 11 which stated that “the content and style of writing in this lesson convey the impression that its content is worth knowing” (M=4.1, SD=0, 96). On

the other hand, the item which had the lowest mean was item 12 saying "This material was more difficult to understand than I would like for it to be" (M=1.33, SD=0, 78). In other words, items which were appreciated highly by students revealed that AR technology materials had positive impact on increasing learners' motivation towards vocabulary learning in language classroom.

Question 1 what was the effect of materials designed with AR technology on learners' motivation?

Table 3

Descriptive statistics of materials designed with AR technology in terms of subfactors

Subfactors	**M**	**S.D.**
Attention _relevance	3,94	,72
confidence_satisfaction	3,96	,69
Motivation_ALL	3,95	,64

According to the descriptive statistics of materials designed with AR technology in terms of sub factors, the means of two sub factors were almost equal. More elaborately, attention-relevance sub factor had a mean of 3, 94 (SS=.073) and the mean of confidence and satisfaction sub factor was 3, 97 (SS=0.7). Overall mean for two sub factors was measured as 3, 95 (SS=0, 65). Considering the sub factors and all the items in the survey, the mean was almost four out of five. In other words, the materials designed in accordance with AR technology had a positive effect on increasing students' motivation towards learning vocabulary.

Question 2 was there a significant difference between the use of augmented reality technology and learners' motivation in terms of gender?

Table 4

The use of augmented reality technology and learners' motivation in terms of gender

Subfactors	**gender**	**N**	**M**	**S.D.**
Attention _relevance	female	82	3,92	,74
	male	47	3,97	,70
confidence_satisfaction	female	82	4,06	,72
	male	47	3,81	,62
Motivation_ALL	female	82	3,99	,67
	male	47	3,89	,60

According to Table 4, no statistically significant difference was found between female and male participants as a result of independent sample t test, even though the mean of male participants (X=3,97) was higher than female participants (X=3,92) in terms of attention and relevance sub factor. On the other hand, there was statistically significant difference on behalf of females T (127)=1.93, p<0,005) in terms of confidence- satisfaction subfactor as the mean of females (X=4,06) was higher than the mean of males (X=3,82). All in all, there was no statistically significant difference between two genders towards motivation (X female =4.0, X male =3, 9).

Question 3 was there a significant difference between the use of augmented reality technology and learners' motivation in terms of majors?

Table 5

The use of augmented reality technology and learners' motivation in terms of majors

Subfactors	Majors	M	S.D.
Attention _relevance	Turkish Language Teaching	4,09	,69
	Computer and Instructional Technology	3,65	,84
	Psychological Counseling	3,92	,63
	Theology teaching	4,02	,70
	Total	3,94	,72
confidence_satisfaction	Turkish Language Teaching	3,98	,67
	Computer and Instructional Technology	3,76	,76
	Psychological Counseling	4,01	,66
	Theology teaching	4,04	,69
	Total	3,96	,69
Motivation_ALL	Turkish Language Teaching	4,04	,64
	Computer and Instructional Technology	3,71	,71
	Psychological Counseling	3,96	,55
	Theology teaching	4,02	,64
	Total	3,95	,64

According to Table 5, the students from Turkish Language teaching had the highest mean in terms of attention- relevance subfactor (X=4,1). As of confidence-satisfaction sub factor, the highest mean belonged to the Theology teaching students (X=4.05). In total, it was revealed that the major of Turkish Language Teaching had the highest mean (X=4.04). As a result of ANOVA analysis, no statistically significant difference was found between majors in terms of sub factors and in total.

Question 4 was there a correlation between the use of augmented reality technology and academic achievement of the learners?

Table 6

The correlation between motivation and academic achievement

	points	Attention _relevance	confidence_satisfaction	Motivation_ ALL
Pearson Correlation	1	,074	,21*	,151
Sig. (2-tailed)		,400	,024	,091

According to Pearson Correlation analysis which was carried out to determine whether there was a significant difference between sub factors and academic achievement of the participants, a positive significant correlation was found between academic achievement and the confidence and satisfaction sub factor ($R=0.21$, $p<0.05$). In other words, the high achievers in English course had high level of motivation in terms of confidence and satisfaction sub factor towards the use of AR technology in language classroom.

DISCUSSION

This study which adopted a descriptive research model aimed to determine the motivational level of the participants in a language classroom towards course materials designed in accordance with augmented reality technology and to identify the correlation between academic achievement and motivational level towards this material. As El Seyad et al. (2011) pointed out the literature on the use of AR technology in education mainly focused on the development, usability, and initial implementation of AR technologies. It could be

stated that almost all the literature emphasized positive influence of AR applications on education. What made this study different from the others was to investigate the role of gender and academic achievement in the use of AR applications and their relations with participants' motivational level. In addition, conducting such a study in the field of foreign language education gave pedagogical implications to researchers whose main interest was AR applications in this area.

Considering all the items in the survey, items which were appreciated highly by students revealed that AR technology materials had positive impact on increasing undergraduate students' motivation towards vocabulary learning in language classroom. Di Serio et al. (2013) had similar findings in their studies in Spanish context yet a different field; they revealed that augmented reality technology had a positive impact on the motivation of middle-school students in a visual art course. However, they did not mention the relations between motivation and academic achievement. The findings of Ibanez et al. (2011) were also in consistent with the results of the present study. The results of their study suggested that using augmented reality in learning Spanish increased students' motivation and learning outcomes.

The findings of Mahadzir & Phung (2013) also supported our findings and they revealed that AR pop-up book contributed to learning requirements, success opportunities, personal control, intrinsic reinforcement and extrinsic rewards in English learning. In addition, they found that AR technology increased students' performance by providing more inspiring environment for students.

As from the role of gender in terms of motivation to AR technology, no statistically significant difference was found between two genders towards motivation even though genders sometimes prevail one another in accordance with sub factors. This finding could be

considered significant in AR applications, because no study was found in the current literature investigated the role of gender on this topic in foreign language education.

The result of the present study also proved that no statistically significant difference was found between majors in terms of sub factors and in total. In other words, the use of AR technology in language teaching helped to increase undergraduate students' motivation without discriminating any majors. This finding could also be considered significant, because it highlighted the role of various majors' motivational level in the use of AR technology.

This study also signified that a positive significant correlation was found between academic achievement and the motivation in the use of AR technology in language classroom. The current literature supported this finding (Tan & Lui, 2004; Lui et al., 2010; Ibanez et al., 2011; Barreira et al., 2012; Perez-Lopez & Contero, 2013; Silva et al., 2013; Mahadzir & Phung, 2013). A Mobile-Based Interactive Learning Environment (MOBILE) developed by Tan & Lui (2004) and a hand-held augmented reality mobile English learning system (HELLO) designed by Lui et al. (2010) proved that learners' performances were increased as a result of AR application in foreign language learning.

CONCLUSION

In conclusion, it is an inevitable fact that augmented and virtual reality, various media tools will be more indispensable part of our life in the near future. Therefore, these media tools should be adapted to educational setting, because one of the primary goal of education is to prepare the individuals to real life. Taking into consideration the new profile of learners, new technological tools are more motivating and interesting for them. It should be reminded that these technological tools provide a more creative learning environment and help to overcome rote learning. Considering these benefits, its adoption to education is expected to make education more productive and enjoyable. On this path, teachers should be informed about advantages of these technologies and be encouraged to use them in the classroom.

There is a common belief that old generation teachers are afraid of using technology in the classroom. These applications should be introduced to teachers via in-service training or by visiting schools.

The use of AR technology particularly in language classroom will provide richer learning environment which is one of the essentials of language learning. As this technological tool offers many input channels such as sound, animation, pictures, it will make learning more productive, effective, interesting and faster.

Although the contribution of AR technology on education has been proved in various studies, these researches on this issue are at the beginning level. As an implication for further researches, some experimental studies which are very few can be conducted about the effectiveness AR applications on various age groups and new AR software can be developed and updated in parallel to innovations in this field.

REFERENCES

Aziz, K., Aziz, N., Yusof, A.,& Paul, A. (2012). Potential for providing augmented reality elements in special education via cloud computing. *International Symposium on Robotics and Intelligent Sensors, Procedia Engineering, 41,* 333-339.

Azuma, R. (1997). A survey of augmented reality. *Presence, 6(4),* 355-385

Azuma, R., Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. (2001). Recent advances in augmented reality, *Computers Graphics and Applications, 21,6,* 34-47.

Barreira, J**.,** Bessa, M., Pereira, L.C., Adao, T., Peres, E**.,** & Magalhaes, L**.** (2012). MOW: Augmented reality game to learn words in different languages: Case study: Learning English names of animals in elementary school. *7th Iberian Conference on Information Systems and Technologies (CISTI),1-6.*

Bujak, K., Radu, I., Catrambone, C., MacIntyre, B., Zheng, R,, & Golubski, G. (2013). A psychological perspective on augmented reality in the mathematics classroom. *Computers & Education 68*, 536–544.

Chang, G., Morreale, P. & Medicherla, P. (2010). Applications of augmented reality systems in education. D. Gibson and B. Dodge (Eds), *Proceedings of Society for Information Technology and Teacher Education International Conference*, 1380-1385. Chesapeake, VA: AACE.

Chen, K-H. & Tsai, C-C. (2012). Affordances of augmented reality in science learning: Suggestions for further research. *Journal Science Education and Technology*, *22*, 449-462.

Di Serio, A., Ibáñez, M., & Kloos, C. (2013). Impact of an augmented reality system on students' motivation for a visual art course, *Computers & Education 68*, 586–596.

Dori, Y., & Belcher, J. (2005). How does technology-enabled active learning affect undergraduate students' understanding of electromagnetism concepts? *Journal of the Learning Sciences, 14,2*, 243-279.

Dunleavy, M., Dede, C., & Mitchell, R. (2009). Affordances and limitations of immersive participatory augmented reality simulations for teaching and learning. *Journal of Science Education and Technology*, 18 (1), 7-22.

El Sayed,, N.M., Zayed, H. H., & Sharawy, M. I. (2011). ARSC: augmented reality student card–an augmented reality solution for the education field. *Computers & Education, 56 (4)*, 1045–1061.

Ibáñez, M., Kloos, C., Leony, D., Rueda, J., & Maroto, D. (2011). Learning a foreign language in a mixed- reality environment, *Internet Computering IEEE, 15, 6*, 44-47.

Ivanova, M.,& Ivanov, G. (2011). Enhancement of learning and teaching in computer graphics through marker augmented reality technology. *International Journal on New Computer Architectures and their applications, 1(1),* 176-184.

Kaufmann, H., & Schmalstieg, D. (2003). Mathematics and geometry education with collaborative augmented reality. *Computers & Graphics, 27(3),* 339–345.

Keller, J. M. (1987). IMMS: *Instructional materials motivation survey*. Tallahassee, Florida: Florida State University.

Klopfer, E., & Squire, K. (2008). Environmental detectives: the development of an augmented reality platform for environmental simulations. *Educational Technology Research and Development, 56(2),* 203–228.

Kutu, H. & Sozbilir, M. (2011). Adaptation of Instructional Materials Motivation Survey to Turkish: A Validity and Reliability Study. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education (5),1,* 292-312.

Lee, S.W.Y., Tsai, C.C., Wu, Y.T., Tsai, M.J., Liu, T.C.,& Hwang, F.K. (2011). Internet-based science learning: A review of journal publications. *International Journal of Science Education, 33 (14),* 1893–1925.

Liu, T. T., & Chu, Y. (2010). QR code and augmented reality-supported mobile English learning system. *Mobile Multimedia Processing Lecture Notes in Computer Science, 5960,* 37-52.

Macmillan Dictionary retrieved from http://www.macmillandictionary.com/dictionary

McMillan, J.H. & Schumacher, S. (2006). *Research in Education. A Conceptual Introduction.* New York: Longman.

Mahadzir, N., & Phung, L. (2013). The use of augmented reality pop-up book to increase motivation in English language learning for national primary school. *Journal of Research & Method in Education, (1) 1,* 26-38.

Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1994). Augmented reality: a class of displays on the reality virtuality continuum. *Proceedings the SPIE: Telemanipulator and TelepresenceTechnologies, 2351*, 282–292.

Núñez, M., Quirós, R., Núñez, I., Carda, .J B., & Camahort, E. (2008). Collaborative augmented reality for inorganic chemistry education. *Proceedings of the 5th WSEAS/IASME International Conference on Engineering Education*, 271-277.

Pérez-López, D., & Contero, M. (2013). Delivering educational multimedia contents through an augmented reality application: A case study on its impact on knowledge acquisition and retention. *TOJET: The Turkish Online Journal of Educational Technology*, *12*,*4*,19-28.

Siltanen, S. (2012). Theory and applications of marker-based augmented reality. Retrieved from http://www.vtt.fi/inf/pdf/science/2012/S3.pdf

Silva, M., Roberto, R., & Teichrieb, V. (2013). Evaluating an educational system based on projective augmented reality. *II Congresso Brasileiro de Informática na Educação (CBIE 2013). XXIV Simpósio Brasileiro de Informática na Educação*.

Singhal, S., Bagga, S., Goyal, P., & Saxena, V. (2012). Augmented chemistry: Interactive education system. *International Journal of Computer Applications, 49 (15),* 1-5.

Tan, T., & Liu, Y. (2004). The mobile-based interactive learning environment (MOBILE) and a case study for assisting elementary school English learning. *Proceedings of the IEEE International Conference on Advanced Learning Technologies.*

Ternier, S., Klemke, R., Kalz, M., Ulzen, P., & Specht, M. (2012). AR learn: augmented reality meets augmented virtuality. *Journal of Universal Computer Science, 18(15), 2143-2164.*

Wojciechowski, R., & Cellary, W. (2013). Evaluation of learners' attitude toward learning in ARIES augmented reality environments, *Computers & Education, 68,* 570–585.

Wu, H., Lee, S., Chang, H., & Liang, J. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education 62*,41–49

Yang, Y. F. (2011). Engaging students in an online situated language learning environment, *Computer Assisted Language Learning, 24(2),* 181-198.

Yuen, C. S. (2011). Augmented reality (AR) in education. *Presentation in Creating Futures through Technology Conference,* Mississippi, Retrieved from http://www.slideshare.net/scyuen/augmented-reality-ar-in-education.