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Review on Augmented Reality Applications in Education

[1] Priya Porwal, [2] Dr. Kamatchi Iyyer

[1,2] *CSE Department, Amity University Mumbai, Mumbai Pune Expressway,Panvel 41020, India*
Priya.porwal20@gmail.com, kiyer@mum.amity.edu

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Abstract: - In today's modern age technology has reached every aspect of our lives. It is imperative to consciously use technology to make teaching and learning effective in our education system. Augmented Reality (AR) allows us to see real world with virtual elements. It is a new 3D technology that merges physical and digital world in real time. This paper illustrating the previous studies and research conducted in different subjects in education system including Inorganic Chemistry, Geosciences, Astronomy and soft teaching through children storytelling etc., using Augmented Reality. In all the studies and research conducted on education system, it was common finding that understanding of students about particular topic or subject has improved using AR technology as compared to traditional methods. It's just a beginning and lot yet to be done to introduce technology in education system for the betterment of our society and nation. The previous research and studies has covered many topics and provides guidance to us to take forward the research into other related fields to achieve the common objective of 'Betterment of education system'. I have identified and chosen to propel the research into 'Engineering Education'. Engineering is complex subject and includes many diverse areas like Computers, Civil and Mechanical to name few. I feel there is a huge possibility to create applications using AR which can help stakeholders (teachers and students both) understand and make understand complex subject easily by showcasing results/outcomes in virtual environment. AR applications should be created in such a way that it is worldwide accepted and can be implemented in engineering colleges at reasonable cost and should not be privy to few colleagues, after all "Shiksha pe Sabka Haq Hai".

Keywords: AR, Augmented Reality, Education, Engineering Education.

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1. Introduction

Technology is rapidly changing and its faster than ever in this 21st century. In last few years we have witnessed the change in technology in almost every field from household appliances, where machines have replaced human efforts like never before. Manual cars have been replaced by automatic cars in western countries. In India, process has been already initiated to transform from fuel based cars to electronic cars by 2030.Most obvious change, which has some or other way have affected everyone's way of living is smart phones. No one could have imagined the way phones are now being used 15 years ago. It has

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made many things obsolete and in future that count will increase only. There are so many changes and it is obviously not possible to mention all technological changes and advancement that have happened in this century here, but the point I want to make is everything in this world changing at rapid pace and no field can remain untouched by it.

I don't have any hesitation in acknowledging that traditional methods of teaching do have its own merits and advantages but at the same time ascribed to the change in time, it requires certain improvements. These improvements can be made by adapting appropriate technology. With mobile devices, users can have AR experience anywhere, which means that students can remain actively engaged in the learning process outside as well as inside classroom [10]

I have experienced and observed many times in my teaching career that students find easy if any topic is explained with live examples, through videos etc. rather than through theoretical explanation. The main reason for this is human mind adapts to the things it sees and hears together, way faster than what it only hears. Think if professors explain any topic in 3D technology where students can see and feel things happening virtually in front of them in real time, how fast they would grasp the subject matter. Augmented Reality (AR) already implemented and tested in primary and secondary education as well as in various sector like museum exhibits, architecture, archeology, manufacturing, clinical psychology etc. Now, we need to take this step further by introducing AR in higher education.

The beginning of AR happened in 1960s when Sutherland used Head Mounted Display (HMD) to represent 3D Graphics [7] Azuma has stated following advantages of AR: 1.One can get 3D information based on real scene. 2. One can see objects from their own viewpoint. 3. One can interact with both real and virtual objects. In 1990s conferences began on AR around the world.

In the following section, a review about the benefits of using 'Augmented Reality' in primary as well as higher education is presented. The results are observed and analysis is given and in final section possible future work and conclusion is presented.

2. Literature Review

Virtual interactive teaching environment (VITE) was developed in 2001 that uses XML and Augmented Reality to teach top down design with VHDL for Integrated circuit design course [12]. In 2002 as an application for engineering education Multimedia Augmented Reality Interface for E-learning(MARIE) [6] has been developed for topic Moore Machine flow chart, which uses lightweight head mounted display(HMD), a camera and a computer.

Lee had conducted a pilot study using 'Skills Arena', a mathematics video game, used to supplement traditional curriculum and teaching methods in 2004[9]. The study was conducted on 39 second grade students and it was observed that students were able to solve 3 times more problems in 19 days. The impacts of the study are 1.Teachers reported improvement in classroom discipline. 2. Students themselves learnt and able to solve difficult problems (by increasing the speed at which questions travel across the screen without direct intervention of teachers.) 3. Increase in involvement of all students and helping other students.

In 2005, to detect chemical properties of caffeine a preliminary experiment was conducted using handheld PC and HMD presentation.[4] The Earth, Sun and Moon relationship was developed by Kerawalla using virtual mirror interfaces in 2006 [2]. The challenges faced while implementing AR in classrooms was 1) teacher's training for teaching topics with AR 2) Time taken was same as traditional system 3) Taking care of curricular requirements 4) content flexibility [2]. Then a ready to use notebook was tested on chemistry topic "structure of molecules" in 2011 [3]. Construct3D [5], a 3D geometry construction tool for mathematics and geometry education was designed.

An Augmented book called AR-Dehaes has been designed in 2010 to provide 3D virtual model that helps students to develop their spatial ability during short remedial classes. A validated study with 24 Mechanical Engineering students concluded that training has a positive impact on students. It is easy to use, attractive for students with cost effective feature as it required only ordinary PC and webcam [17]. There is an opportunity to explore more complex interactions to enrich feature set in AR book.

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In 2011 [13] Andujar proposed a new concept, Augmented Remote Laboratories (ARL) which is developed for first and second years of industrial and computer engineering. ARL allows students to explore learning experiences that are better from those offered by traditional laboratory classes. The effectiveness of this lab is calculated by comparing it to practical sessions in the lab with the same group of students. A questionnaire was completed by students and the result shows that use of ARL improve students' outcome. Herranz provided data about the impact of practical application of AR technology (Desktop AR) on the learning and motivation of participant students in 2013[15]. The author has conducted a pilot study on third graders where content about natural and social sciences have been used a teaching tool.

Martin offered a learning process from electrical machines course in electrical engineering degree. It supports an interactive and autonomous study as well as collaborative performances of laboratory practices with other students [18].Block puzzle education system was designed based on augmented reality for infants or children in 2016. They are able to enjoy play and learn at the same time. It visualize 3D model of block puzzle and creates special effects, it also generate words and sound to make children naturally learn words. Using this, children are able to build creativity, fine motor skills, perception of objects and language education [19]. The children creativity is built by various ways of thinking, especially education for providing a sense of achievement by fine motor skill and adjustment is a good means for activating brain [14].

The various applications of AR in education in primary and secondary school is summarized in the below table, where it is found that AR had positive impact on student's understanding, evaluated based on their results when they were taught using AR techniques in compare with traditional classroom.

A. Table illustrating following facts

The below table represents a summary about previous experiments conducted using AR in primary and secondary education in geosciences, chemistry, and chemical sciences, Mathematics and kids game. When studied about various uses of AR in education it was common finding that the students' results as well as their understanding about the topic were improved. Some facts on above study:

a) Mainly tools delineated for primary and secondary level students. The tools can be designed for higher education.
b) The parameter to judge the effectiveness was basically questionnaire, feedback, survey, no quantitative analysis is performed.
c) The tools are more helpful to weak and average students to improve grades, less effect on good students.
d) Extravagant.

Table 1 Summary of selected subjects on AR with results

	per title/Author	pic or subject	periment	ethod	chnology	e group	sults
	aking it real': exploring potential of augmented lity teaching primary hool science / Kerawalla Luckin R, Seljeflot S, olard A. 2006 [2]	oscience	mparison of dialogue ed by teachers engaged teaching about earth, n and moon using AR d traditional Methods.	ta Sources – 1) deo recording of ching session d audio cordings of erviews with cher	rtual-Mirror erfaces using mputer screen and iteboard	idents 9-10 ars and ir teachers m 5 ndon hools	Teachers are sitive Students perience and feel earth, sun and on.
	gmented Reality in ucation/ Otília saréti1, Huba Hajdú1, más Matuszka1. 2011	emistry	ady to use notebook s tested on the emistry topic – ructure of molecules	lit students into 2 ups 1) Students th AR rsebook and 2) idents without R rsebook(control up). 3 tests each questions were nducted among th groups	R Markers egrated into fmade lesson Plan AR exercise ok. And web meras used by idents	secondary hool with 4 students m class 9 d 10	e AR group/control up has achieved .74/77.78% in task 59.57/48.89% in sk 2 and .09/62.22% in Task was observed. So experiment was ccessful. Both chers and students ve positive opinions out AR Manuals.
	gmented Instructions - Fusion of Augmented ality and Printed arning Materials / Asai Kobayashi H, Kondo 2005 [4]	emical properties caffeine	preliminary experiment investigate aracteristics of gmented instructions emical properties of ffeine). A handheld PC	e participants re required to d two page cument and see a Model with the esentation	o presentation stems 1) Handheld with webcam tebook. 2) HMD d Qcam Pro 4000. me format was	university idents (15 men and 7 n)	estionnaire was ed. The results ply that handheld is more favorable n a HMD esentation.

			s compared to HMD	stems	ed to present 3-D odel of caffeine		
	Construct3D: An Augmented Reality Application for athematics and ometry Education/ nnes Kaufmann 2002	athematics and ometry Education	tool "construct3D" was veloped that uses AR ough which students n actually see 3D objects ich they till now had to culate through ditional method(pen and per)	e construct3D fers basic set of actions like lines, ints, planes, pes, sphere, linders and hes. The tool is ectly given to dents.	All construction eps are carried out via direct manipulation in 3D using a stylus tracked with six egrees of freedom. AR affords hat users see their wn body and hand well as the effects of eir actions while rking.	gh school dents	ey got positive ponse from 14 dents. They keep trial. Due to some oblems construct3D not used regularly t constantly their plication is proving. ervention of ditional resources also important.
	SMART: a System of Augmented Reality for Teaching 2nd Grade Students/ Freitas R, Campos P. 2008[8]	mes: Animal ssification game d 2)identify the nsportation egory	ildren hold one racquet visualize different 3D mated models of mals. ildren need to identify nsportation category.	on correct ntification the me will provide dio feedback and incorrect, plays ong-buzzer und. One is ntrol group using ditional method d other is perimental group	esults analyzed by watching recorded movies of their reactions	cond Grade several tal school udents age ries from 7 d 8. 32 nales and males.	udents divided into ee categories weak, erage and good. e results shown that od students don't prove much but ect is higher in eak and average dents.

3. Future work

After going through previous research on AR, it was observed a positive impact of using AR on both teachers and students in education field. The students learning capability also increases, same reflected in their results. Spare tools can be implemented in engineering field. So this motivates us to create more such applications in education field. The different authors have used different tools; all have focused more on students understanding of the topic, but at the same time cost of using tools is high. More knowledge is required for hardware. So in future the effect of using different tools on same applications can be analyzed. As the basic motive to develop such application is to make such studies available to all the students, if it will be cost effective it will easy to install and use by different educational organization.

4. Conclusion

Multiple experiments have proven that Augmented Reality based tools can improve the learning and teaching experience by providing clarity on complex subjects and concepts. This gives the chance to both students and teachers to delve into the subject and improve their understanding and understand the real world application of those concepts. If these AR tools can be used in optimal manner in primary, secondary as well as in higher education, then we can develop deeper understanding of various concepts in students and which could ultimately lead to improvement in the technology, products and services we use.

References

[1] Shelton BE. Augmented reality and education: Current projects and the potential for classroom learning. New Horizons for Learning. 2002;9.

[2] Kerawalla L, Luckin R, Seljeflot S, Woolard A. "Making it real": exploring the potential of augmented reality for teaching primary school science. Virtual Reality. 2006 Dec 1;10(3-4):163-74.

[3] Pasaréti O, Hajdin H, Matusaka T, Jambori A, Molnar I, Tucsányi-Szabó M. Augmented Reality in education. INFODIDACT 2011 InformatikaSzakmódszertaniKonferencia. 2011.

[4] Asai K, Kobayashi H, Kondo T. Augmented instructions-a fusion of augmented reality and printed learning materials. In Advanced Learning Technologies, 2005. ICALT 2005. Fifth IEEE International Conference on 2005 Jul 5 (pp. 213-215). IEEE.

[5] Kaufmann H. Construct3D: an augmented reality application for mathematics and geometry education. InProceedings of the tenth ACM international conference on Multimedia 2002 Dec 1 (pp. 656-657). ACM.

[6] Liarokapis F, Petridis P, Lister PF, White M. Multimedia augmented reality interface for e-learning (MARIE). World Transactions on Engineering and Technology Education. 2002 Jan 1;1(2):173-6.

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

[8] Freitas R, Campos P. SMART: a SysteM of Augmented Reality for Teaching 2 nd grade students. InProceedings of the 22nd British HCI Group Annual Conference on People and Computers: Culture, Creativity, Interaction-Volume 2 2008 Sep 1 (pp. 27-30). BCS Learning & Development Ltd.

[9]Lee J, Luchini K, Michael B, Norris C, Soloway E. More than just fun and games: Assessing the value of educational video games in the classroom. InCHI'04 extended abstracts on Human factors in computing systems 2004 Apr 24 (pp. 1375-1378). ACM.

[10] Billinghurst M, Duenser A. Augmented reality in the classroom. Computer. 2012 Jul;45(7):56-63.

[11] Liarokapis F, Mourkoussis N, White M, Darcy J, Sifniotis M, Petridis P, Basu A, Lister PF. Web3D and augmented reality to support engineering education. World Transactions on Engineering and Technology Education. 2004 Jan 1;3(1):11-4.

[12] White M, Jay E, Liarokapis F, Kostakis C, Lister P. A virtual interactive teaching environment using XML and augmented reality. International Journal of Electrical Engineering Education. 2001 Oct;38(4):316-29.

[13] Andujar JM, Mejías A, Marquez MA. Augmented reality for the improvement of remote laboratories: an augmented remote laboratory. IEEE transactions on education. 2011 Aug;54(3):492-500.

[14] Shardul Gurjar, Hinal Somani, "A Survey on Use of Augmented Reality in Education"2016 IJEDR | Volume 4, Issue 4 | ISSN: 2321-9939

[15] Salvador-Herranz G, Pérez-López D, Ortega M, Soto E, Alcañiz M, Contero M. Manipulating Virtual Objects with your hands: A case study on applying Desktop Augmented Reality at the Primary School. InSystem Sciences (HICSS), 2013 46th Hawaii International Conference on 2013 Jan 7 (pp. 31-39). IEEE.

[16] Maier P, Klinker G. Augmented chemical reactions: An augmented reality tool to support chemistry teaching. InExperiment@ International Conference (exp. at'13), 2013 2nd 2013 Sep 18 (pp. 164-165). IEEE.

[17] Martín-Gutiérrez J, Saorín JL, Contero M, Alcañiz M, Pérez-López DC, Ortega M. Design and validation of an augmented book for spatial abilities development in engineering students. Computers & Graphics. 2010 Feb 28;34(1):77-91.

[18] Martín-Gutiérrez J, Fabiani P, Benesova W, Meneses MD, Mora CE. Augmented reality to promote collaborative and autonomous learning in higher education. Computers in Human Behavior. 2015 Oct 31;51:752-61.

[19] Oh YJ, Suh YS, Kim EK. Picture puzzle augmented reality system for Infants creativity. In Ubiquitous and Future Networks (ICUFN), 2016 Eighth International Conference on 2016 Jul 5 (pp. 343-346). IEEE

