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An E-Assessment Framework for Blended Learning with Augmented Reality to Enhance the Student Learning

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ABSTRACT

The study compared the students' level of understanding using two scenarios i.e. S1 (Classroom Lectures) and S2 (Lectures based on AR). An independent sample t-test was applied to correlate the results of two groups (experimental and control) and paired sample t-test was applied to evaluate the two scenarios S1and S2 within two groups: the experimental and the control. When the effect of augmented reality in blended learning framework is broke down, it is examined that augmented reality learning outperform classroom learning environment in enhancing students' performance. The result revealed that there is a difference between classroom learning and AR learning. AR experiences have positive effect on students' learning. Furthermore, students' confidence and motivation towards learning are achieved.

Keywords: e-learning, blended learning, virtual reality, augmented reality.

INTRODUCTION

As trends of learning are improving rapidly, anything can be accessed easily through information and communication technologies. Innovative ideas and developments are proposed along with exploration of existing projects and implementations. Inter-communication among people of mutual interests at any far distant places is possible within

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State of the literature

- The adaptation of the technology is essential as technologies are more affordance for the education and assessment (Qteishat et al., 2013).
- Bernard composed a system for better understanding and viability of Blended Learning (BL) in advanced education (Bernard et al., 2014).
- Yousef broke down the examination of VBL (Video Based Learning) distributed in 2003-2013 to construct a profound comprehension of VBL and instructive advantages and viability in the fields of educating and learning (Yousef, Chatti, & Schroeder, 2014).
- In the recent decade trends of learning are improving rapidly, the increasing interests have led simple learning to blended learning (Bell & Federman, 2013).
- Collaborative learning as students can collaborative with groups of student to elaborate their knowledge (Adamson et al., 2014; Radu, 2014).

Contribution of this paper to the literature

- By using the AR in BL environments, students' academic achievement and students' learning attitude can be improved.
- In this study a framework for BL techniques with the incorporation of Augmented Reality is introduced to enhance learning curve of the student.
- The learning contents, which are learn via online learning through AR are memorized more strongly by students.

no time. Schools are simply not completely effective in the current world if they are not helping students to engage in learning through the vast quantitative and qualitative online resources. A traditional solution to address related problems is to deliver lectures in the classrooms, which is not fully effective and economical. Student neither grasp nor effectively understand the concepts in traditional learning or in simple book reading. The trend of learning is improved from simple learning to eLearning and then leads to Blended Learning (BL). BL is the concept that combines the advantages of e-learning with traditional methods of learning that is face-to-face interaction in classrooms (Wu, Lee, Chang, & Liang, 2013). It is the learning program where more than one methods of concept delivery are being used to enhance student learning and to decrease the cost of the program. Sometimes, a student want to see pictures or animations to elaborate his concepts instead of simple text reading within blended learning. This concept refers towards Augmented Reality. Augmented Reality is a concept in which real world is enhanced by blending it with the virtual world (Cai & Song, 2012). AR is the mixture of virtual environments where AR users can see the real with the virtual objects that are synthesized with the real world (Gutiérrez & Fernández, 2014). Augmented Reality and Virtual Reality use same equipment advances and share loads of variables as in PC produced virtual scenes, 3D articles, and intuitiveness. The primary contrast is the place virtual reality expects to supplant this present reality while augmented reality consciously supplements it (Kesim & Ozarslan, 2012). Many researchers have

identified that AR has immense ability to improve learning and teaching (Bower et al., 2014). AR intends to give an inclination to its clients that are unequivocally like real communication with genuine situations. Moreover, through the showcase of virtual messages, clients get messages that they would not be capable of getting from this present reality (Zhang et al., 2014). AR concept can be considered as the "Reality–Virtuality Continuum" that is depicted in **Figure 1** (Milgram, Takemura, Utsumi, & Kishino, 1995). The importance of this AR in education is discussed in subsequent sub-section.

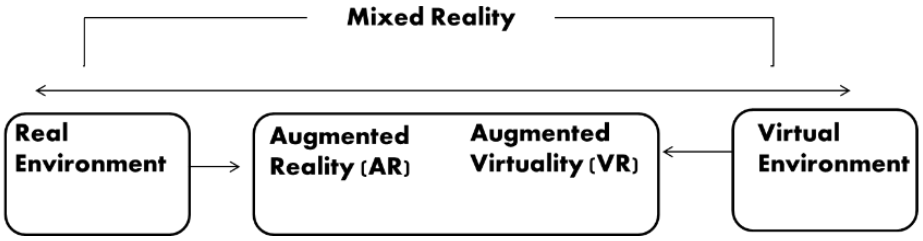

Figure 1. Reality–Virtuality Continuum

Augmented Reality in Education

Augmented Reality is utilized as a part of the fields of designing, medicine, engineering, art, manufacturing, oil and gas, civil, commerce, construction, psychological treatments etc. Nowadays, it is associated with attainment, stimulation, or learning by enhancing a customer's insight and a joint effort with this present reality. The client can see the 3D virtual picture and view the picture from any viewpoint, much the same as a genuine item (Kesim & Ozarslan, 2012). Recently it is applied in the field of education to enhance user's perception. AR is being used to enhance students' understanding in the field of science and medical (Hsiao et al., 2012; Mitchell, 2011, Saltan, & Arslan, 2017; Górski, Buń, Wichniarek, Zawadzki, & Hamrol, 2017). It provides a logical and smooth connection between virtual objects and the real world, permits the client to watch and comprehend this present reality with virtual items. Virtual objects using in Augmented Reality are video, sounds, 3D objects, and interactivity. The major devices of Augmented Reality are Head Mounted Displays, tracking systems, input devices and computers. In past research, the researcher stated that AR increases contents understanding as students can experience AR to clear their concepts and learning enhancement. Contents learned by AR, remind more strongly by students as compared to non-AR experiences. AR is most effective to perform a physical task and increases student motivation. AR is a source of collaborative learning as students can collaborative with other groups of student to elaborate their knowledge. Besides, the way of communication with learning encounters is changing: Students don't just utilize animates to associate with on-screen content (conceivable with customary desktop programming), however now, understudies can use their whole body to take up with informational substance that appears to exist in the physical world (conceivable through enlarged reality innovation) (Radu, 2014). Augmented Reality has been utilized to build up understudies' understanding of science, including natural science (Squire & Klopfer, 2007), biomedical

science (Yusoff, Zaman, & Ahmad, 2011) . Gamification and pretend based AR have been connected to improve inspiration and a feeling of realness in restorative science (Rosenbaum, Klopfer, & Perry, 2007). The situation based "Outsider Contact" recreation has been used to create numerical speculation aptitudes (Dunleavy & Dede, 2014). There have been outlines of how AR could be utilized in the humanities for occurrence through arrangement of artistic experience (Billinghurst, Kato, & Poupyrev, 2001) and through the advancement of visual verse (Jabbar, Naseer, Gohar, Rho, & Chang, 2016; Naseer, Jabbar, & Zafar, 2014).

LITERATURE REVIEW

In preceding years, AR is designed to impact learner's understanding in the fields of medical, science and education. Though, most of the work is done in teaching with e-learning, blended learning, MOOCs and augmented reality, yet closely related work is summarized in subsequent paragraphs.

Bernard et al. (2014) composed a system for better understanding and viability of BL in advanced education (Bernard et al., 2014). The outcomes accomplished by meta-examination of relative investigations of BL and Classroom Instructions (CI). Graham et al. (2013) determined the requirement for hypothetically grounded research by investigating the connection between fulfilment information and mixed learning technique and adequacy (Graham). They inspected the writing identified with learning satisfaction, effectiveness of learning and cost effectiveness and analyzed the various definitions of literature with their effectiveness and strength. Cochrane et al. (2014) built up a system for inventive instructional methods by means of Bring Your Own Device (BYOD) utilizing versatile online networking (Cochrane et al., 2014). This study demonstrated communitarian edge by means of setting up educator groups of practice, to find out about the affordances of cell phones, about new methods of understudy learning for synergistic and base advancement over the grounds. M. Fahmy Yousef et al. (2014) broke down the examination of video based learning distributed in 2003-2013 to construct its profound comprehension and instructive advantages and viability in the fields of educating and learning (Farhan, Aslam, Jabbar, & Khalid, 2016; Yousef, Chatti, & Schroeder, 2014). In this survey, 67 peers considered papers were chosen and subjective mapping methodology was utilized to delineate exploration into four fundamental measurements to be specific, viability, showing strategies, outline, and reflection to upgrade the learning techniques. Yoon et al., 2012 concentrated on utilizing the expanded reality and learning building frameworks in the field of science exhibition hall to affect reasonable information and attitudes in formal classrooms (Yoon et al., 2012). Ericson C. Santos et al., 2014 reviewed the applications and found 87 research articles on expanded reality learning encounters (ARLEs). A large portion of these articles directed client studies, and some of these permitted the calculation of an impact size to the execution of understudies in a test (Santos et al., 2014). In their meta-examination, they performed a subjective investigation on the outline perspectives for ARLEs and accomplished a generally variable impact on understudy execution with a mean impact size of 0.56. They showed three points of interest of AR through the embodying models and ground these focal points

to sight and sound learning hypothesis, experiential learning hypothesis, and vivify vision hypothesis that intended to illuminate the outline of future ARLEs. M. Gheisari et al. (2015) introduced Augmented Panorama and a work process for making an enlarged all-encompassing environment (Gheisari, Sehat, & Williams, 2015). Expanded all-encompassing environment conveys physical areas nearer to online clients. It is, as another medium and strategy for showing understudies in an online situation, demonstrated that MOOCs and online training can possibly give a proper learning environment to development related instruction. D. Fonseca et al., 2014 depicted the usage and assessment of an examination using AR development in the representation of 3D models and demonstration of outline endeavors by understudies of configuration and building planning (Fonseca et al., 2014). The goal was to evaluate the practicality of utilizing AR on cell phones as a part of instructive situations and to research the relationship between the convenience of the device, understudy cooperation, and the change in scholastic execution after utilizing AR.

Radu et al. (2014) reviewed the 26 publications that were a comparison of AR and non-AR experiences in student's learning. They highlighted the list of good and bad impacts of AR in students' learning and also identified the factors that effect thereon (Radu, 2014). Based on the research, a questionnaire was generated to judge learning potential of AR experiences. Wu et al. (2013) described the definitions and taxonomies of AR and define some features and applications of AR (Wu et al., 2013). Based on research, design and learning experiences are more important than compiling features. In research, three categories i.e. roles, tasks and locations of instructional approach are discussed to help students' learning, and outline some basic issues which affect utilization of AR in learning. Bower, M., et al., 2014 reviewed the uses of AR in education and society. They also discussed the pedagogical capacity supported by the AR (Bower et al., 2014). Using AR in high school, it was indicated that the approach resulted in improvement of students' learning attitude.

Chiang et al. (2014) described an area based on AR with the 5-stage directing system is produced to teach the understudies for data sharing in request learning exercises. To assess the adequacy of this approach regarding advancing the information sharing practices of understudies, an examination has been led in a grade school's regular science course. It was concluded that in the examination with the ordinary request occupying versatile learning development, the AR-based request learning action can connect with the understudies in additional connections for learning development (Chiang, Yang, & Hwang, 2014). Augmented Reality has been utilized to build up understudies' understanding of science, including natural science (Squire & Klopfer, 2007), and biomedical science (Yusoff et al., 2011). Gamification and pretend based AR has been connected to improve inspiration and a feeling of realness in restorative science (Rosenbaum et al., 2007).

METHODOLOGY

The proposed framework is an output of synergistic mating of AR and BL that is comprising of distinctive modules that are further partitioned in a few segments. The segments are

accumulated by various sources, as in the module of E-Learning, the segments i.e. video, sound, slides, educators, and understudies are joined to finish premise of E-Learning (Smith, 2010). Further, these modules are consolidated to make mixed learning situations. The system is intended to apply AR on the mixed learning situations. Work process of the framework is depicted in **Figure 2**.

The proposed framework consists of different modules in blended learning that are combined in blended learning and modules of AR. AR is used in this blended environment to enhance student learning.

Table 1 shows the experimental setup of the framework. The framework is designed in such a way that AR is applied in both cases: classroom learning and online learning in a blended environment. For classroom learning, an AR app is created with the name of "myAR" using PhoneGap (Zibula & Majchrzak, 2012). PhoneGap is a software development tool with web technologies; HTML, CSS and JavaScript. For online learning AR shows 3D models of images on my web page. Model is demonstrated in **Figure 3.**

The study was conducted on four sections of a high school in Wah (Pakistan). Forty-five students were selected in this study. Their age limit was 15 - 17. Among them, 21 were female and 24 were males. Only 3 students out of 45 had the smartphone and previous knowledge of augmented reality. The topic global warming was selected from the textbook of general science. The experiment was performed on two-session-modules. The module material consisted of text, images, and slides related to the topic, was presented by teachers of the school.

In first session, teachers presented the lecture by using text, images or slides (S1) and scenario of the second session was based on using Augmented Reality technology (S2) (Di Serio et al., 2013).

- ***S1:*** The session S1 consisted of a selected topic from the textbook using slides, images, and relevant text. Students received the lecture in the blended environment (classroom learning + e-learning). As in blended learning, students can attend lectures in the classroom and the distinct students can also attend the same lecture online using their Wi-Fi connections. Both types of students are involved in this study.
- ***S2:*** The second session comprised of some other topic from the same chapter of the textbook using simple text, videos, audios and 3D models. AR was utilized to upgrade the data about the chosen subject pertinent to the course. AR device was used in the classroom to superimpose the virtual reality in the real-world contents and 3D models are applied on images in online lectures.
- The purpose of the study was to clarify the difference between two selected scenarios; S1 (Classroom Lectures) and S2 (Lectures based on AR) of study on student's learning. The study considering a subjective examination to decide the impact of AR on understudies learning.

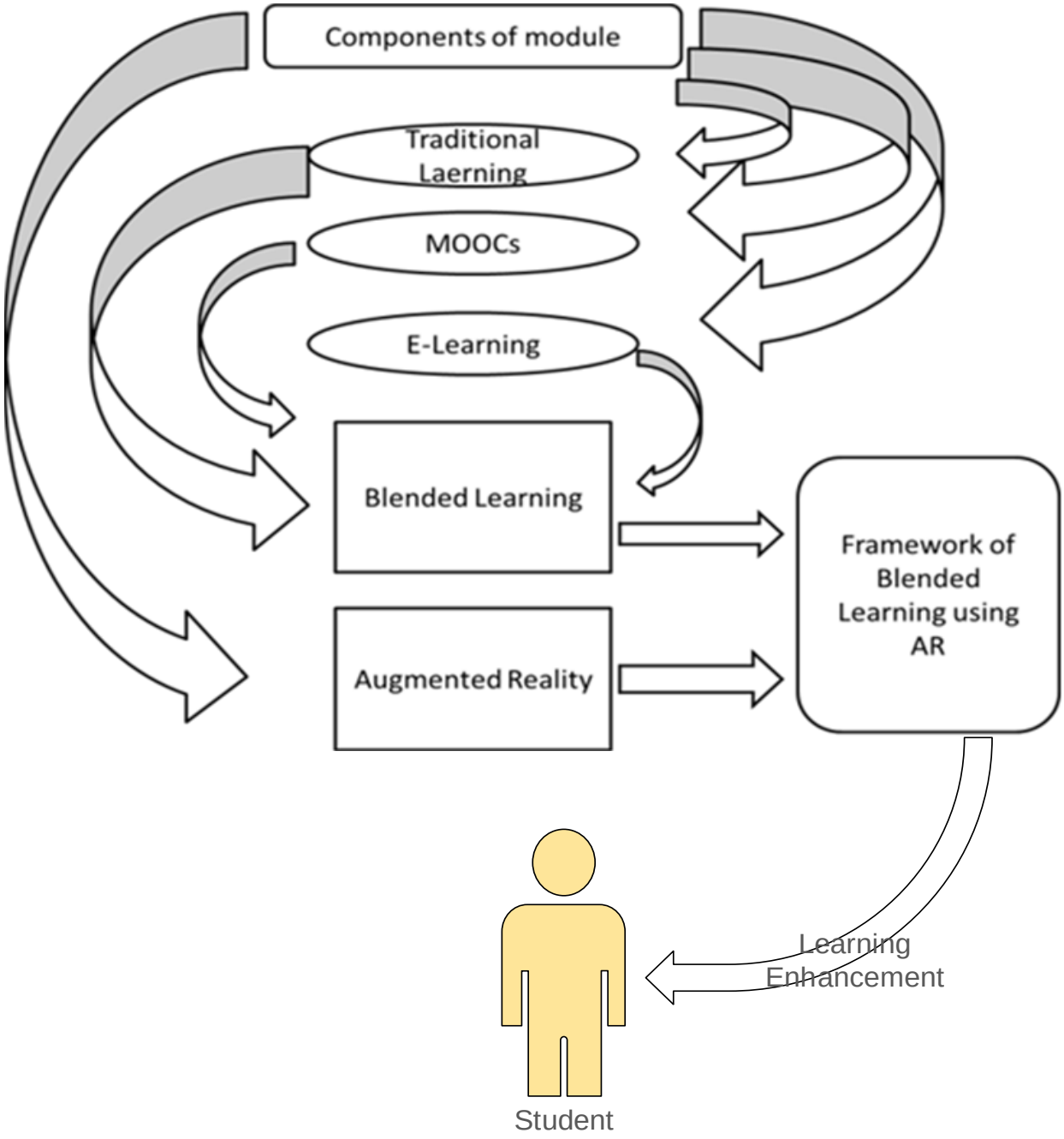

Figure 2. Workflow of framework of blended learning using AR

Table 1. Experimental setup

Tools	Specification
Laptop	64-bit operating system, Intel Core(TM) M-5Y10c CPU 2.80GHz 8.0 GB RAM
Android Mobile	Samsung Galaxy S7
PhoneGap	V 1.0.2
WampServer	V 2.2
VR Box	

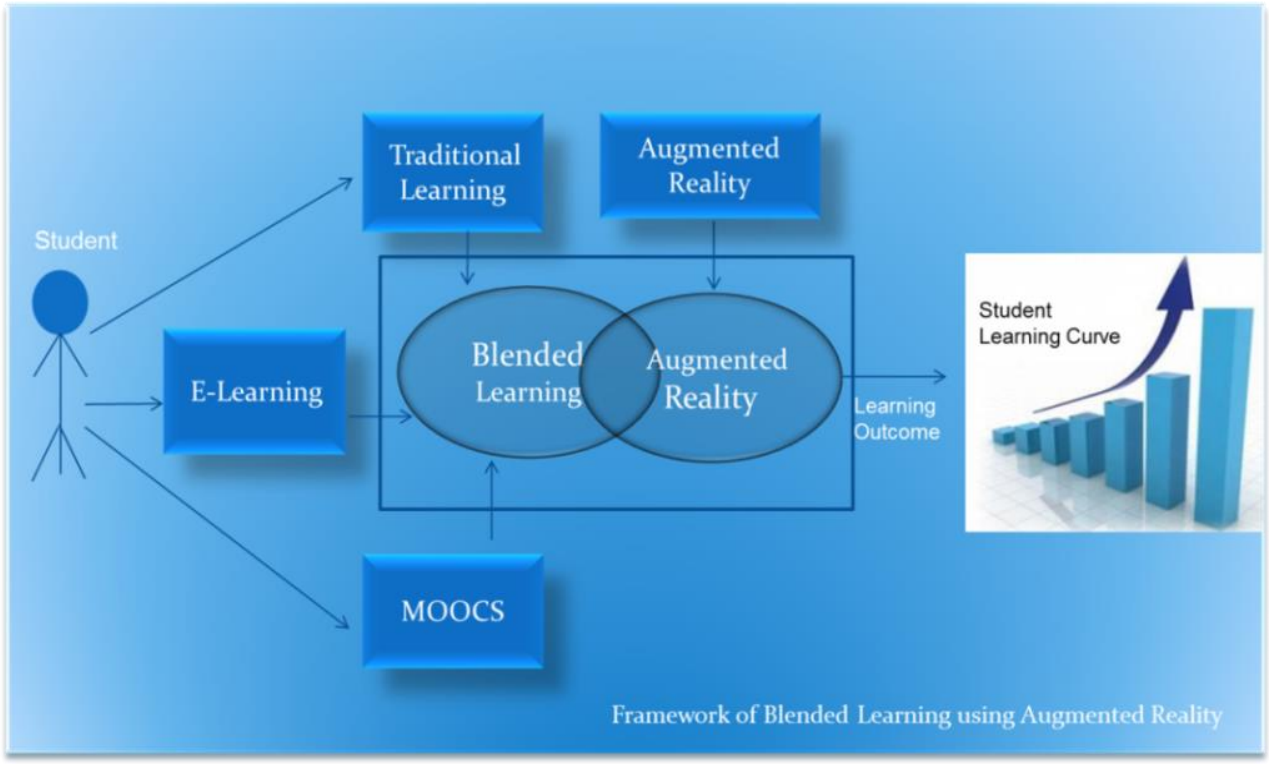

Figure 3. Framework of blended learning using augmented reality

The research was based on following two questions:

- ***Q1:*** What are the learning benefits of using blended learning and AR technologies to transform formal learning into blended AR learning?
- ***Q2:*** What are the learning benefits of using blended learning with Augmented Reality to enhance understanding of concepts?

The students were divided into two groups naming with the experimental group and the control group. All students were selected randomly in two groups. The experimental group had 23 students and 22 students were in the control group. Within the blended environment, the experimental group consisted of students that were physically present in the classroom and experienced augmented reality using app "myAR" in their smart phones. The control group consisted of students that attended the lectures online and experienced the AR through 3D models applied on images, videos, and lectures. All students participated in both learning scenarios, S1 and S2. An independent sample t-test was applied to correlate the results of two groups and paired sample t-test was applied to evaluate the two scenarios S1and S2 within underdiscussed two groups. The quantitative data was collected by using motivational measurement instruments. The motivational instrument was applied to both types of students within the blended environment. After the first session S1, the motivational measurement instrument IMMS (Keller, 2010) (see Appendix A) was utilized to measure the students' motivation. The same questionnaire was used after the completion of the second session S2. Finally, paired sample t-test was collected to evaluate the motivation of participants (Di Serio et al., 2013).

The qualitative data was collected to observe the students while they were interacting with AR within the blended environment and by conducting interviews after the session S2. The motivational instrument IMMS is a situational measure of student's motivation was designed by John Keller. The model is established by using Keller's ARCS motivation model (Keller, 1987). The IMMS model has 36 questions with response scale 1-5 and reliability coefficient of 0.96. The instrument was somewhat changed to adjust its wording to the augmented reality field.

RESULTS and DISCUSSION

This research was based on two hypotheses. Results were evaluated using these research questions.

Result Q1: What are the learning benefits of using blended learning and AR technologies to transform formal learning into blended AR learning?

- In the session S1, there were 36 minima and 180 maximum scores of the instrument IMMS and response scale was 1 - 5. Total score of experimental group ranges from 93 to 140 while control group's score ranges from 80 to 120. This means that experimental group outperformed the other in session S1.

- In the session S2, total scores of the experimental group range from 115 to 169 and control group ranges from 97 to 146.

It is intuited from the results that experimental group achieved greater marks than control group in both sessions. Also in S2, students achieved higher marks than S1. In this study, it was determined that students were motivated in S1 i.e. Classroom Lectures and highly motivated in scenario S2 i.e. Lectures based on AR. It was also concluded that the use of blended learning and AR technologies to transform formal learning into blended AR learning enhanced the students' learning.

Result Q2: What are the learning benefits of using blended learning with Augmented Reality to enhance better understanding of concepts?

Table 2 shows the statistical description of the four subscales used in IMMS to enhance students' motivation.

Table 2 depicts that the mean score for S2 is higher than S1. The mean difference between S2 and S1 for subscale attention is 0.953, subscale relevance difference between S2 and S1 is 0.5, confidence is 0.5 and subscale satisfaction has a difference of 0.38. Results showed that S2 has a greater mean value of all subscales than S1. Also in S2, the subscale confidence achieved higher mean than all other subscales. Moreover, using blended learning with AR technology enhanced the understanding of concepts and confidence level of students.

Table 2. Description of all subscales

Subscales	S1		S2	
	Mean	SD	Mean	SD
Attention	3.25	1.164	3.75	0.886
Relevance	2.667	1.0	3.62	0.916
Confidence	3.37	1.187	3.87	0.991
Satisfaction	3.12	0.991	3.5	1.06

Independent sample T-Test was conducted on S2 to calculate the difference of the two underdiscussed groups. The null hypothesis H0 is rejected which indicates that there is a difference between two groups as the experimental group has a higher mean than the control group. There is strong confirmation ($t = 2.018$, $p = 0.000$) that experimental group with AR in blended learning improves marks. Illustrated below is the box plot of two groups achieved marks of using posttests.

A Sample Paired T-Test was applied for the evaluation of the pretest and posttest results of two selected groups individually. **Table 3** shows that there is a difference between two tests while experimental group is to be focused. As posttest, had higher mean value and variance than pretest, the difference between two means is 27.522. t = 2.074, p = 0.000 clearly proved that students' learning is enhanced after experiencing AR.

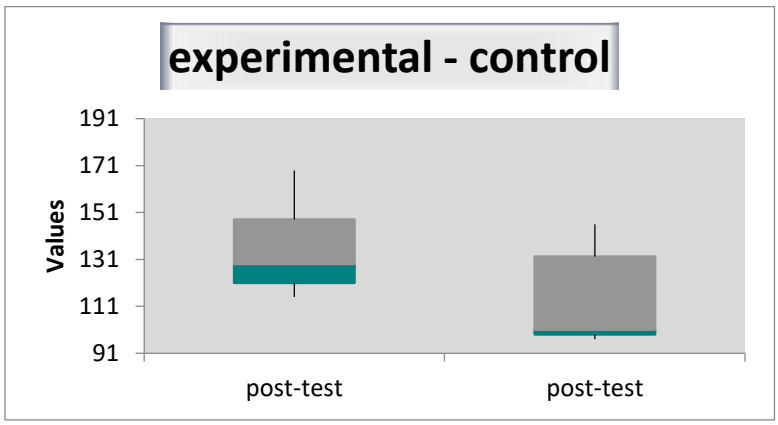

Figure 4. Box Plot of post-test results of two groups: experimental and control

Table 3. Independent t-test of two groups: experimental and control

Unequal Sample Sizes	Classroom AR *post-test*	Online AR *post-test*	diff	95% Confidence Interval	
Mean	136.2609	114.3182	21.943	10.657	33.228
Variance	340.4743	362.3225			
Observations	23	22			
Hypothesized Mean Difference	0				
df	42				
t Stat	3.924				
P(T<=t) one-tail	0.000				
T Critical one-tail	1.682				
P(T<=t) two-tail	0.000				
T Critical Two-tail	2.018				

In **Figure 5** plot diagram is used to clarify the differences between two tests having an experimental group.

As Sample, Paired T-Test is conducted to clarify the difference between pretest and posttest of the control group**. Table 5 (**t= 2.080, p= 0.002) depicted that student's motivation of learning is achieved after experiencing AR technology with the blended learning.

Illustrated below is the difference graph of two tests, while the control group is in focus. **Figure 6** show box plot to show the difference in the result of pretest (scenario S1) and posttest (scenario S2).

Table 4. Sample paired t-test of experimental group

	pre-test	post-test	diff	95%	Confidence
Mean	108.7391	136.2609	-	-36.039	-
Variance	297.9289	340.4743			
Observations	23	23			
Pearson Correlation	0.393269				
Hypothesized	0				
Df	22				
t Stat	-6.702				
P(T<=t) one-tail	0.000				
T Critical one-tail	1.717				
P(T<=t) two-tail	0.000				
T Critical Two-tail	2.074				

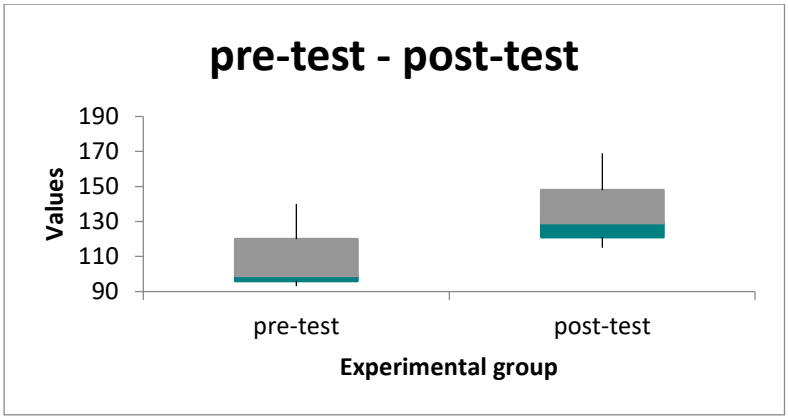

Figure 5. Difference plot diagram using experimental group

Table 5. Sample paired t-test for control group

	pre-test	post-test	diff	95% Confidence Interval		
Mean	98	114.3182	-	-	-	
Variance	183.9048	362.3225				
Observations	22	22				
Pearson Correlation	0.110316					
Hypothesized Mean	0					
df	21					
t Stat	-3.460					
P(T<=t) one-tail	0.001					
T Critical one-tail	1.721					
P(T<=t) two-tail	0.002					
T Critical Two-tail	2.080					

CONCLUSION

The study presented a framework of using AR in BL environments to enhance students' learning. The study discovered that students neither grasp nor effectively understand the concepts in traditional learning or in simple book reading as compared to learning with AR. The study compared the student's level of understanding using two scenarios i.e. S1 (Classroom Lectures) and S2 (Lectures based on AR). It is clearly intuited from the results that students with AR experiences have a better understanding. The total 45 students of a high school were selected to test the framework. The selected students were divided into two groups; the experimental group, and the control group. IMMS questionnaire was used to test the students. Both groups of students participated in S1 and S2. All the four subscales used in IMMS showed that S2 has higher Mean values than S1 with the difference in attention is 0.953, relevance is 0.5, confidence is 0.5 and subscale satisfaction is 0.38. Independent T-Test was organized to calculate the difference of the two groups and Paired Sample T-Test was organized within two groups to find out the difference between S1 and S2. In **Table 2**, t=2.018, p=0.000 strongly evidence that experimental groups are better and achieved a better understanding of students with AR experiences. **Table 4** showed the difference between two means posttest and pretest is 27.522. t=2.074, p= 0.000 clearly proved that S2 achieved better results than S1. Thus, student after S2 were more confident and motivated towards learning enhancement. Finally, it was proved that S2 is better than S1 while the control group is in consideration. As there is a difference of 16.318 between pretest and posttest mean values.

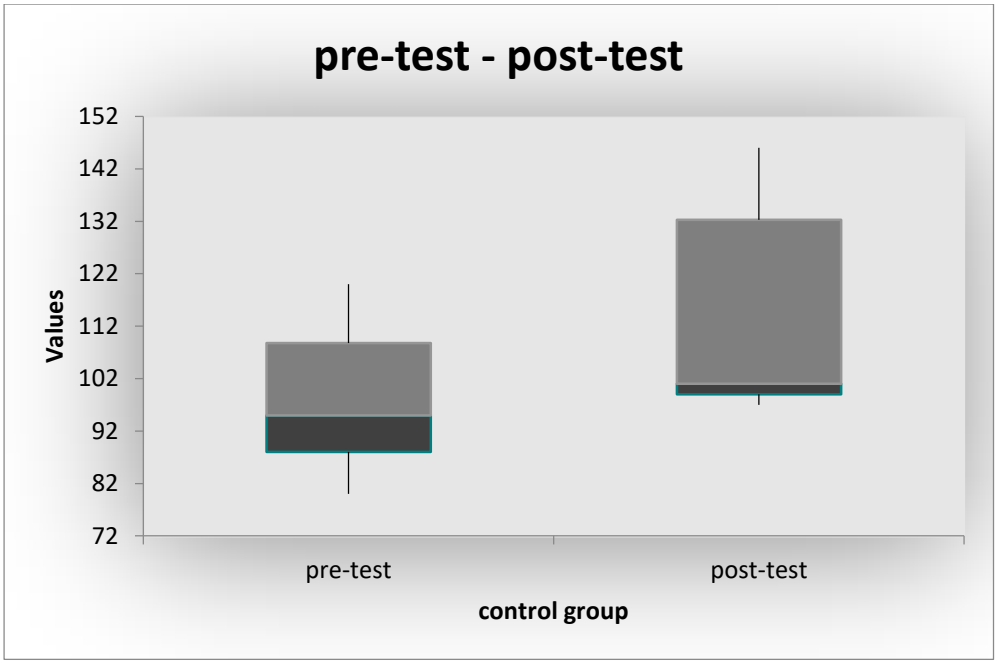

Figure 6. Difference between two tests of control group

The result revealed that AR experiences enhanced the students' learning and students' motivation towards learning. The proposed framework can be extended through its integration with Internet of Things (Paul, Ahmad, Rathore, & Jabbar, 2016) and Social Internet of Things (Jabbar, Khan, Silva, & Han, 2016) to facilitate the evaluation process of students learning and to provide the better learning resources based on received feedback.

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APPENDIX A

Questionnaire designed according to AR and adopted using

Instructional Materials Motivation Survey
by John M. Keller

The response scale ranges from 1 to 5. 1 is equal to "Not true", 2 is equal to "Slightly true", 3 is equal to "Moderately true", 4 is equal to "Mostly true" and 5 is equal to "Very true". The survey has 36 items with minimum score of 36 and maximum 180.

The Questionnaire consists of four subscales confidence, attention, satisfaction, and relevance. Each question related to which subscale is mentioned below:

Confidence

1. When I first looked at this lesson, I had the impression that it would be easy for me.
2. The AR was more difficult to understand than I would like for it to be.
3. After reading the introductory information, I felt confident that I knew what I was supposed to learn from AR experiences.
4. Many of the pages had so much information that it was hard to pick out and remember the important points.
5. As I worked on this lesson, I was confident that I could learn the content.
6. The exercises in this lesson were too difficult.
7. After working on this lesson for a while, I was confident that I would be able to pass a test on it.
8. I could not understand quite a bit of the AR in blended learning.
9. The good organization of the content helped me be confident that I would learn this AR technology.

Attention

10. There was something interesting at the beginning of lesson using AR that got my attention.
11. These materials are eye-catching.

12. The quality of the writing helped to hold my attention.
13. This lesson is so abstract that it was hard to keep my attention on it.
14. The pages of this lesson look dry and unappealing.
15. The way the information is arranged on the pages helped keep my attention.
16. This lesson has things that stimulated my curiosity.
17. The amount of repetition in this lesson caused me to get bored sometimes.
18. I learned some things that were surprising or unexpected.
19. The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the lesson.
20. The style of writing is boring.
21. There are so many words on each page that it is irritating.

Satisfaction

22. Completing the exercises in this lesson gave me a satisfying feeling of accomplishment.
23. I enjoyed this lesson so much that I would like to know more about this topic.
24. I enjoyed studying through AR.
25. The wording of feedback after the exercises, or of other comments in this lesson, helped me feel rewarded for my effort.
26. It felt good to successfully complete this lesson.
27. It was a pleasure to work on such a well-designed AR in blended learning framework.

Relevance

28. It is clear to me how the content of this material is related to things I already know.
29. There were stories, pictures, or examples that showed me how this material could be important to some people.
30. Completing this lesson successfully was important to me.
31. The content of this material is relevant to my interests.
32. There are explanations or examples of how people use the knowledge in this lesson.
33. The content and style of writing in this lesson convey the impression that its content is worth knowing.
34. This lesson was not relevant to my needs because I already knew most of it.
35. I could relate the content of this lesson to things I have seen, done, or thought about in my own life after experiencing AR.
36. The content of this lesson will be useful to me.