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Research Article

Effectiveness of Augmented Reality using Cloud Education System to Enhance Critical Thinking

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Abstract

The study was made to experiment and explore the effectiveness of augmented reality-based Cloud education systems on critical thinking of the students in the Coronavirus Disease 2019 epidemic. Augmented Reality (AR) can help reduce social and business impact while supporting business continuity through epidemics. The study adopted an experimental research design, wherein 42 samples were considered. For the study; Concept visualization, Concept perception, Concept correlation with the real world, Interactive, Concept inferential, and interpretation were considered as study variables associated with critical thinking. The analysis for the study was conducted using SPSS- 23 Application. The study indicated that both male and female respondents agree that the augmented reality helping them better visualize, perceive, interpret, and correlate it with the real world than other conventional and traditional teaching methods. Further, it was identified that Critical thinking of students is strong with Concept visualization, Concept perception, Concept correlation with the real world, Interactive, Concept inferential, and interpretation.

Keywords: Augmented Reality, Cloud Education System, Critical Thinking, COVID-19 epidemic.

1.Introduction

COVID-19 epidemic has unleashed an unprecedented impact on the global business landscape. In recent months, many countries have implemented different types of locks, severely restricting how education systems work via AR. Augmented reality (AR) is an interactive new learning experience of real-world environment designers to create everything from audio to video visuals, from picture to Global Positioning Systems, overlays to digital content, which acknowledges in actual-time to different in the user's environment, usually motion [1]. AR is defined as an organization that satisfies three basic features: a mixture of actual and video-virtual worlds, real-time communications, and an accurate 3D recording of video and audio virtual and real objects

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[2]. The above emotional information is either practical (i.e., in combination with the natural environment), or damaging (i.e., obscuring the natural environment) [3]. In this way, developed reality changes one's current real-surroundings, while virtual reality completely transforms the user's real-world environment into a simulated one. For example, head-up displays on many fighter jets from the 1990s onwards show information about the aircraft's approach, direction, and speed, and only a few years later can they show which objects are in sight.

Figure 1: Augmented Reality(AR)

A standard STEM program that focuses on Science, Technology, Engineering, And Maths to help the students to acquire the skills needed to succeed in today's challenging world [4]. These includes solve complex problems and promote science and technology. Over the earlier decade, only limited studies have sightseen reality (AR) technology that has evolved to engage with innovative and critical thinking in the field of academic research [5].

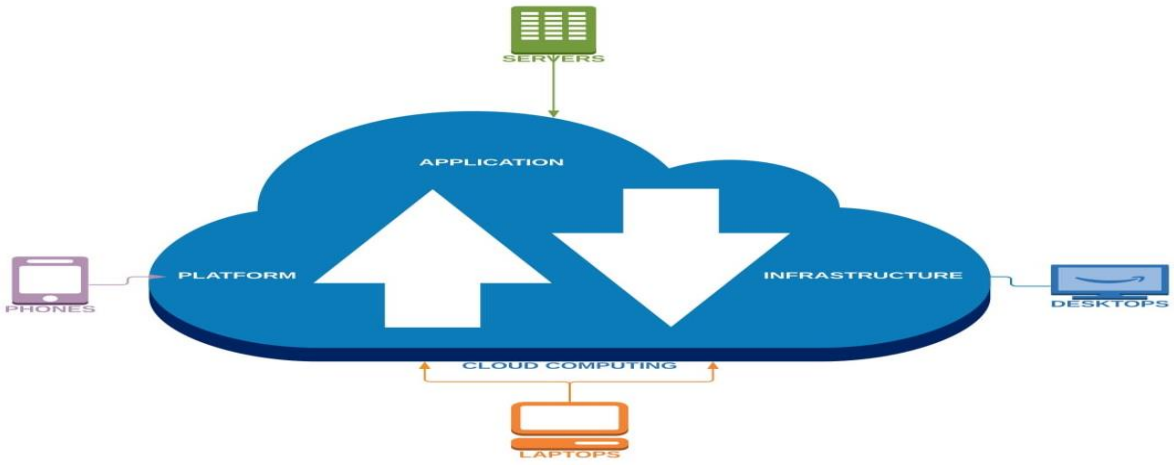


Figure 2: Cloud Computing

Therefore, the use of AR-based learning was avoided and traditional teaching methodology was given more importance [6]. The AR system is based on five critical thinking skills; I.e. Interpretation, Evaluation with the real world, Rationalization, Concept Visualization, and Evaluation to training participants with critical thinking skills during the functioning of the organization [7].

For the study, 42 university students have been selected as participants (18-20 years old) from the first year to engage in the experiments. Tests include tests, intervention, and post-testing to explore the impact and learning effectiveness of using an AR-based cloud education system with critical thinking among students [8].

2.Research Problems

Despite there being studies related to Augmented reality, a cloud-based education system, and critical thinking a study correlating all these three aspects is a long time forgotten. Further, the researcher could find limited studies proving algorithms to develop an augmented reality-based cloud education system but, the researcher couldn't find a real-time study by collecting the data from the respondents upon implementing such a system. Herein, the researcher attempted to make a real-time study upon implementing the exiting augmented reality-based cloud education system. This study would have a great significance on the education system, companies' employee, and employer training method. Also, this study would help in realizing the success of AR-based cloud education system over traditional and other conventional training methods.

3.Objectives of the study

1. The study explores the important aspects of critical thinking that are stimulated during an augmented reality-based cloud education system.
2. The study involves investigating whether the augmented reality-based cloud education system can enhance the critical thinking of the students pursuing STEM [Science, Technology, Engineering, and Maths].
3. To offer possible suggestions for the betterment of the augmented reality-based cloud education system.

4.Review of Literature

Augmented reality is accepted as the main source for education progress within the substructure of the cognitive theory. Furthermore, neuroscience establishes that the spiritual participation of contributor encourages their education [9].

Astronomy stimulates the attentiveness of both sexes at the elementary education level. Like the most nation, topics like Astros, i.e. the education system, are part of the Portuguese curriculum for elementary school grades 1 through 9 (ages five to fifteen) [10].

Technology stimulates the appropriate learning process. Past research has realized the problem. If a used invention is made, then that discovery will be made by the learning process not included. It does not encourage critical thinking and material production in advance. There

seems to be an extraordinary potential for augmenting reality (AR). The learning process is highly dynamic, successful, and important [11].

Implementation of the MAR astronomy game entitled “Solar System GEO” carry out in the casual learning environment during school vacation. The game is immobile existence developed, but to assess its impact on elementary school students, it has already undergone several implementation tests [12]**.**

Inspired by the game of Pokemon Geo, this dissertation suggests a last convocation challenge (targeting high education) and asked that would encourage elementary school students to study [13].

The growing popularity of games in education will have a positive effect on the development of AR in education. The game construction continues to push the dividing line of technology, making the game construction a driving force behind AR [14].

STEM training professionals need to be at the front line of new technology and how it can suitable for their virtual classroom [15].

Undoubtedly, this is necessary for the belief that teacher surrounds themselves with the starter. Participating, intelligent, students interact with opportunities to be more creative [16].

“Immersion” is commonly used as a segment of virtual reality "Spatial immersion", the origin of standard in the **immaterial** world, It is triggered by images, animations, sounds, and more. The user can explore the essential surroundings in 360 degrees [17].

Virtually there are no other human discoveries in reality technology, for example, Taste, Smell, and Touch [18].

Current medical science is well developed. There is a reason for Sophisticated tools to assist physicians in the diagnosis of syphilis Domes. This trend is becoming popular Transidiplex co-operation are required. Therefore, it can be linked AR with the actual investigation involving students [19].

Cardiac catheterization is accomplished by adding a catheterization into the circulatory system. With such slightest invasion, it is possible to treat many arteries and veins diseases [20].

In image refinement using ongoing tools, some restriction in image refinement can lead to the unbalanced organization [21]. Certain conditions for improving AR system performance were defined as to hold attribute and AR system show [22].

5.Research Methodology

For the study, an experimental research design was adopted. Herein engineering class consisting of 42 students were considered. The study was conducted in a time frame of two months involving five faculties specialized in a STEM subject. One unit was taught through the augmented reality-based cloud education system and the response was collected after the assessment though subjects in STEM.

The reliability statists were measured using Cronbach’s Alpha method to check the reliability of the construct named Critical Thinking.

Reliability Statistics				
Cronbach's Alpha		N of Items		
0.813		5		
Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I have a better **visualization** of concept than in traditional and conventional learning methods.	15.619	13.071	0.401	0.835
I noticed I have a better-**perceived** quality of STEM education when teacher through Augmented reality	15.881	12.205	0.618	0.773
I could **correlate** STEM concepts studied through Augmented reality and the real world, to make use of it.	15.619	11.364	0.791	0.726
Unlike other methods Augmented reality is making me more **interactive** with the class and help me learn new concepts every day.	15.7619	9.454	0.759	0.724
The information delivered through augmented reality is stimulating my **inferential and interpretation** ability	15.5952	12.881	0.501	0.805

Source: (Primary data) **Table No. – 1:** Reliability Statistics

The estimated Cronbach's Alpha value was 0.813, which is greater than 0.7. Meaning the construct named Critical Thinking and all its associated items are reliable for conducting further research.

Also, all the variables named; Visualization, Perception, Correlate, Interactive, inferential, and interpretation when examined individually exhibited Cronbach's reliability score greater than 0.7 [Standard Value].

Descriptive statistics were carried by the researcher to identify the average score of each variable considered for the study and sort them using rank.

Descriptive Statistics			
	N	Mean	Rank
I have a better **visualization** of concept than in traditional and conventional learning methods.	42	4	2
I noticed I have a better-**perceived** quality of STEM education when teacher through Augmented reality	42	3.7381	5
I could **correlate** STEM concepts studied through Augmented reality and the real world, to make use of it.	42	4	2
Unlike other methods Augmented reality is making me more **interactive** with the class and help me learn new concepts every day.	42	3.8571	4
The information delivered through augmented reality is stimulating my	42	4.0238	1

inferential and interpretation ability			

Source: (Primary data) **Table No. – 2:** Descriptive Statistics

From the mean score rank analysis, it can be interpreted that, using augmented reality-based cloud education helps students to better interpret, visualize, and correlate STEM concepts with the real world.

Mann-Whitney U test was carried to identify whether there is a significant difference in opinion among the male and female students who had undergone an augmented reality-based cloud education system. Herein the researcher had adopted the Mann-Whitney U test because further the ordinal scale was used to measure the Critical thinking construct having a limited sample size of 42.

Test Statistics	**Mann-Whitney U**	**Z**	**Asymp. Sig. (2-tailed)**
I have a better **visualization** of concept than in traditional and conventional learning methods.	180	-0.247	0.805
I noticed I have a better-**perceived** quality of STEM education when teacher through Augmented reality	130.5	-1.76	0.078
I could **correlate** STEM concepts studied through Augmented reality and the real world, to make use of it.	155	-0.969	0.333
Unlike other methods Augmented reality is making me more **interactive** with the class and help me learn new concepts every day.	144	-1.286	0.198
The information delivered through augmented reality is stimulating my **inferential and interpretation** ability	144	-1.323	0.186

Mode Analysis			
	Valid	Missing	Mode
I have a better visualization of concept than in traditional and conventional learning methods.	42	0	5
I noticed I have a better-perceived quality of STEM education when teacher through Augmented reality	42	0	4
I could correlate STEM concepts studied through Augmented reality and the real world, to make use of it.	42	0	4
Unlike other methods Augmented reality is making me more interactive with the class and help me learn new concepts every day.	42	0	5
The information delivered through augmented reality is stimulating my inferential and interpretation ability	42	0	4

Source: (Primary data)

Table No. – 3: Mann-Whitney U –Gender [Group] and Critical thinking [Construct]

The estimated significance value is greater than 0.05, meaning the null hypothesis is accepted. Therefore it can be interpreted that, there is no significant difference in opinion among the male and female students. From the mode value, it can be interpreted that, students strongly agree that augmented reality-based cloud education is interactive and helps in better visualization of the concept. Also, the students agree that the augmented reality-based cloud education is helping them to better perceive the concept, correlate the concept with the real world, and helps them interpret the STEM concepts well than other conventional and traditional teaching methods.

The Spearman correlation was conducted because the considered dataset has variables whose scale is measured in ordinal further there was a limited sample size of 42.

Correlations - Spearman's rho						
		Concept visualization	Concept perception	Concept correlation with real world	Interactive	Concept inferential and interpretation
Concept visualization	Correlation Coefficient	1	.406**	.341*	0.077	-0.052
	Sig. (2-tailed)	.	0.008	0.027	0.628	0.742
	N	42	42	42	42	42
Concept perception	Correlation Coefficient	.406**	1	.307*	.308*	.352*
	Sig. (2-tailed)	0.008	.	0.048	0.047	0.022
	N	42	42	42	42	42
Concept correlation with real world	Correlation Coefficient	.341*	.307*	1	.581**	.692**
	Sig. (2-tailed)	0.027	0.048	.	0.000	0.000
	N	42	42	42	42	42
Interactive	Correlation Coefficient	0.077	.308*	.581**	1	.433**
	Sig. (2-tailed)	0.628	0.047	0.000	.	0.004
	N	42	42	42	42	42
Concept inferential and interpretation	Correlation Coefficient	-0.052	.352*	.692**	.433**	1
	Sig. (2-tailed)	0.742	0.022	0.000	0.004	.
	N	42	42	42	42	42

Source: (primary data)

Table No. – 4: Spearman's Correlation

The estimated significance value for all variables was measured to be less than 0.05, meaning the null hypothesis is rejected. This indicates, there is a significant relationship between every variable. From, the correlation coefficient value can be further interpreted that there is a significant positive relationship with every variable. Except for the variables visualization with interactive and concept inferential & interpretation whose significance is greater than 0.05, meaning there is no significant relationship between the variables.

Correlations - Spearman's rho		
		Critical Thinking
Concept visualization	Correlation Coefficient	.560**
	Sig. (2-tailed)	0.000
	N	42
Concept perception	Correlation Coefficient	.629**
	Sig. (2-tailed)	0.000
	N	42
Concept correlation with real world	Correlation Coefficient	.827**
	Sig. (2-tailed)	0.000
	N	42
Interactive	Correlation Coefficient	.498**
	Sig. (2-tailed)	0.001
	N	42
Concept inferential and interpretation	Correlation Coefficient	.697**
	Sig. (2-tailed)	0.000
	N	42

Source: (Primary data)

Table No. – 5: Spearman's Correlation – Critical thinking & Study variables

The estimated significance value for all variables was measured to be less than 0.05, meaning the null hypothesis is rejected. This indicates, there is a significant relationship between Concept visualization, Concept perception, Concept correlation with the real world, Interactive, Concept inferential, and interpretation with critical thinking. From the correlation coefficient, t can be interpreted that the Concept correlation with the real world has a strong positive relationship between Critical thinking. Concept visualization, Concept perception, Concept inferential, and interpretation has a positive relationship with Critical thinking, while interactive has a weak positive relationship with critical thinking.

6.Research Significance

In their study on motivation, [*Table No. – 6*] defined a three- classification model for the criterion of stimulus point of view. These criteria are as follows:

1. **Intrinsic motivation**: The individual is truly interested in their work/object and will strive to triumph anyway of struggling or disappointment.

2. **Externally motivated**: The individual is unfulfillment committed to their job/duty, but will execute it to get a recompense or keep away from discipline.

3**. A motivation**: The individual frame of mind towards any duty or project, and it will affect both their stimulus and motivation to triumph.

Within the circumstances of teaching, [23] [*Table No. – 6*] argue that gamified learning qualitatively motivates learners on condition that it satisfies the following intellectual needs:

1. The need for autonomy

2. The need for the ability

3. The need for relevance since magnified reality can advance at their own pace and explore their preferred components [24] [*Table No. – 6*], so there is more energy to motivate them than traditional learning ability.

The theory developed AR in the class-rooms using the provided hardware, although the outcome composed [25] [*Table No. - 6*] from this study could not be fully trusted as they could not divide students. Unfortunately, in the non-attendance of an authority category, it is impossible to obtain from this learning whether the use of developed actuality is harmful to stimulus contrast to standard instruct methods.

Study	Project Name	AR Design Features	Subject Area	Accuracy and Authenticity	Photorealism	Impact on Learning	Emotional Impact
Deci and Ryan	N/A	N/A	General education	N/A	N/A	Different motivational categories and how they impact learning.	N/A
Vansteenkiste et al.	N/A	N/A	General education	N/A	N/A	The impact of motivation on learning	N/A
Roy & Zaman	N/A	N/A	General education	N/A	N/A	Gamified learning and how to implement it within a classroom environment.	N/A
Di Serio et al.	N/A	Mobile devices	Art and history of education	High	N/A	Effect of augmented reality	N/A

Source: (Secondary data)

Table No. – 6: List of Augmented Reality Systems for Education(Performance Metrics)

7.Proposed Augmented Reality using Cloud Education System Architecture

Educating with an awareness of deficit hyperactivity disorder (ADHD) is a provocation. These learners need an exception to differentiate to new students. They attract a low level of attention and are effortlessly inattentive. Single-way data divide that teaching is a data of data does not apply to them. On the other side, good feedback is received from academics regarding the AR-developing new structure to education sectors in the assist E-learning. AR manage the virtual image sharing data and the actual world to be merged, which allows the item of the study, such as the revived, thus breaking the boundaries of time [26].

7.1 Augmented Reality Application(ARA):

Augmented Reality Apps are software applications that integrate digital visual (audio and other genres) content into the user's real-world environment. It has collected 8 examples of magnified reality applications and how they will affect the future of mobile technology. The AR system architecture is mainly three categories like User viewpoint(U), Virtual resource(V), Physical resource(P).

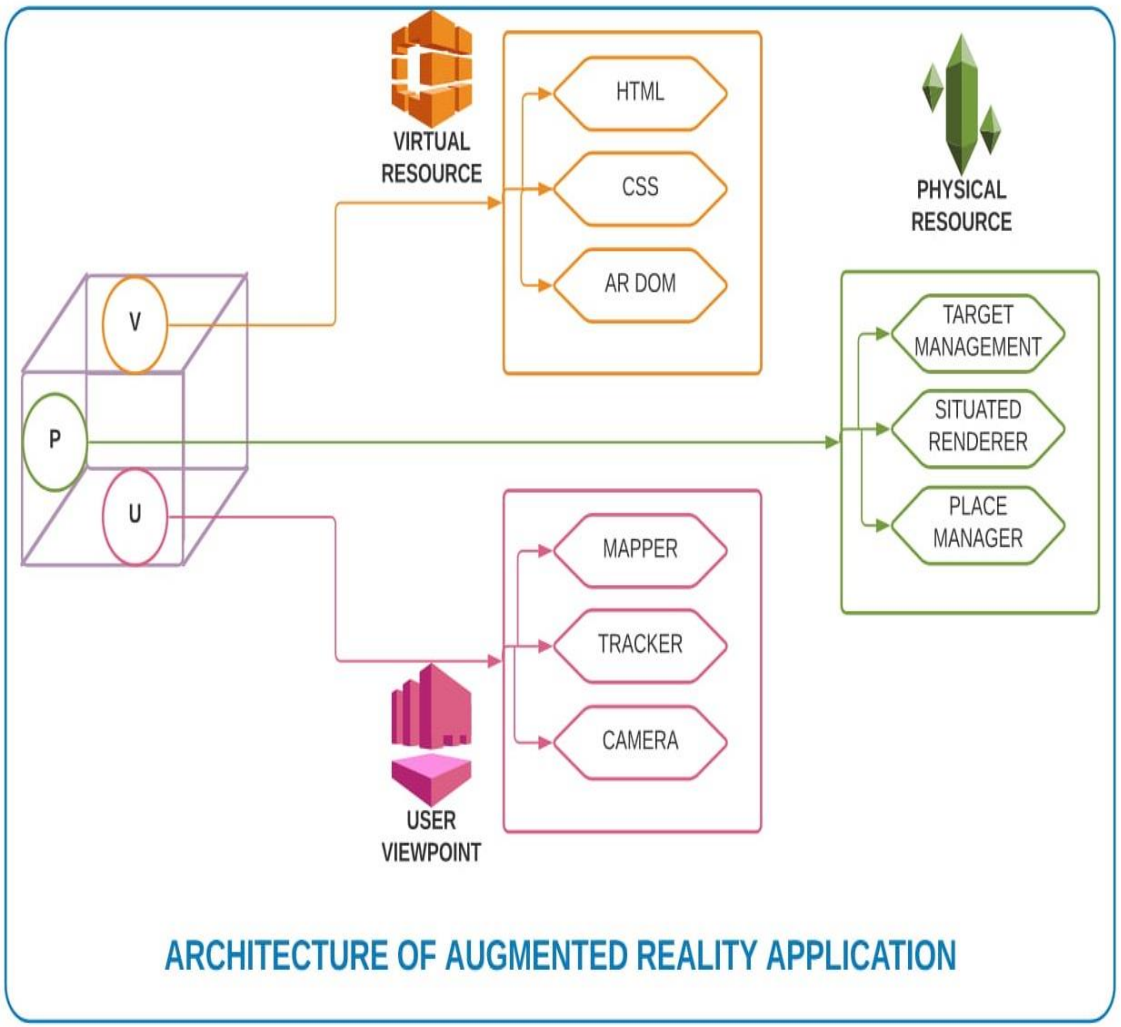


Figure 3: Overview of the Proposed Augmented Reality Application(ARA)-Architecture

7.1.1 Camera Input:

A camera is also an input device because it allows placing digital (pictures) on the computer. The digital video camera captures moving images using technology used by the digital camera.

7.1.2 Request Sender:

Online API testing tool for API developers and testers. Test the API endpoints and web services by making API calls directly from the browser. Load from API or website with hundreds of simulated simultaneous links and Explore third-party APIs.

7.1.3 Visual Tracker:

Consider the performance of each tracker reported on this site to be reasonably low. It can be used as a default parameter (used in the original implementation) for all rows without any tuning. Tracker performance may be updated in later versions.

7.1.4 Result Receiver:

This means it should treat it like this: This class of process does not affect the life cycle management (It must use some high-level components to tell the computer that process should continue), for whatever reason the connection will be broken.

7.1.5 Content Renderer:

A content renderer provides a specific style that displays items details for a different items category, in a diversity of widgets that can display items. LifeFire Commerce offers content renders for every outdoor product category, such as Simple Content Renderer for simple products.

7.1.6 AR Hardware:

Technology that overwrites information about the real-time image in surroundings - advanced technology can bring great advances in construction technology. It has been following its potential in this blog for a while. But AR is still waiting for its outrageous moment.AR hardware divided into four-category like mobile devices, smart glasses, Immersive head-mounted display and web-based AR.

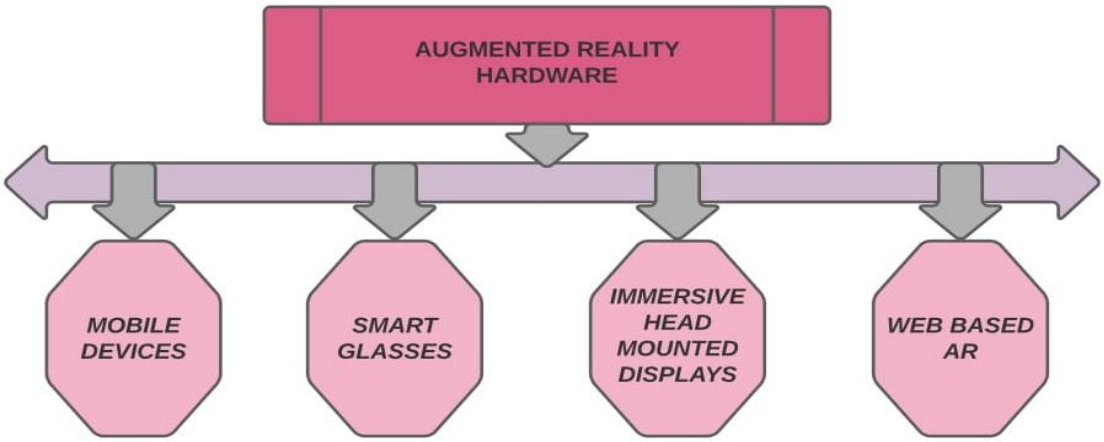


Figure 4: Overview of the Augmented Reality Hardware Architecture

7.2 Cloud For Education

Higher education institutions cultivate an individual culture of facing geographically dispersed campuses across staff, school/college students. Today, nearly 70% of North American graduate school is moving, or in the process of moving, their management systems have come to the

cloud, and about 50% have adopted cloud-based collaboration methods to improve information sharing across campus [27].

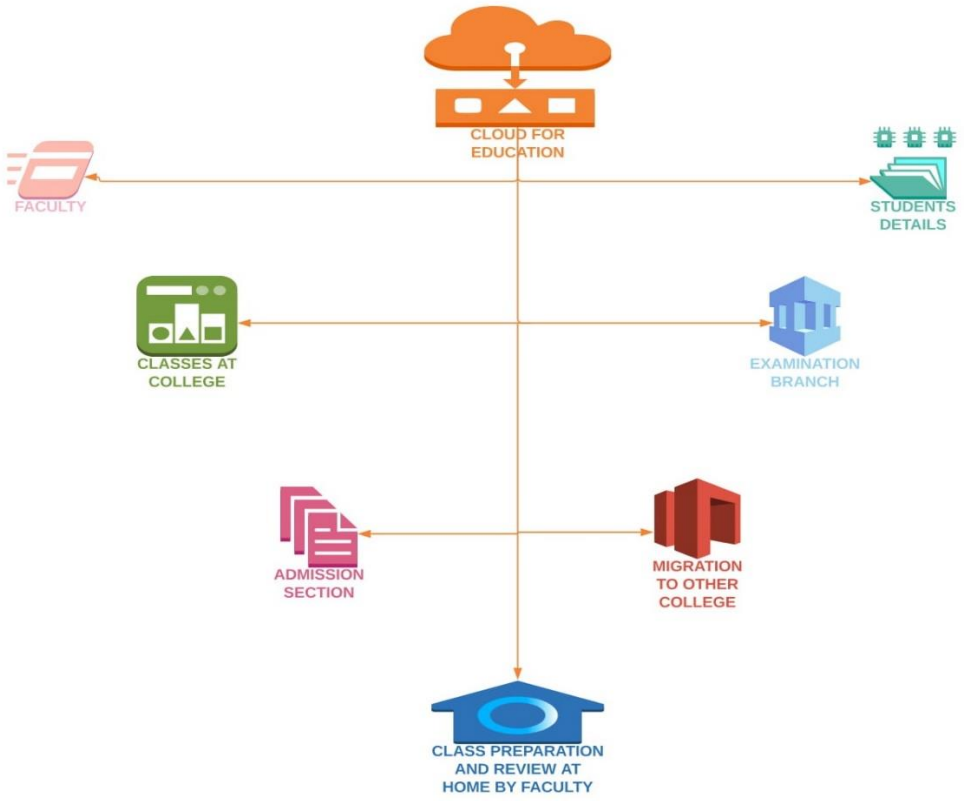


Figure 5: Overview of the Proposed Cloud Education Architecture

7.2.1 Request Receiver:

A receiver is an abstract source created on a chenille machine to handle functional automation. Create a receiver to trigger a specific action on a cluster on behalf of a user when certain external alarms or events are removed.

7.2.2 Task Manager:

When starting Task Manager, management on backdrop applications. They can choose an app here and click the "Finish Task" to close it. If one application does not respond the other says otherwise, if it is frozen - it will not close normally.

7.2.3 Result Sender:

End Metadata for Outgoing Record agreed by Kafka. This conclusion also includes the contact metadata provided in the sender record that was not sent to Kafka, but this response helps to match the request associated with it.

7.2.4 Visual Task Processor:

Task visual management is the best technique for managing the task. Instead of cluttering up to-do lists or spending time tracking information in the inbox, folders, and spreadsheets, monitor work using a visual task management tool such as a task force, project team, or canon / lean visual management board. Some people use plain old white or green board and notes to create a physical concrete board. Whether the task involves big or small projects, using display boards is a good way to focus and get the job done effectively [28].

Imagine how much time to spend before doing the job. “Doing things” is more than just doing the work. Mainly, it requires to imagine what to do upcoming, how to take action, how to prioritize work, and how to increase the impact work do, without maximizing the scope of the project. Also need to think about what resources or skills will be required to complete the job so that do not look down on the team members [29].

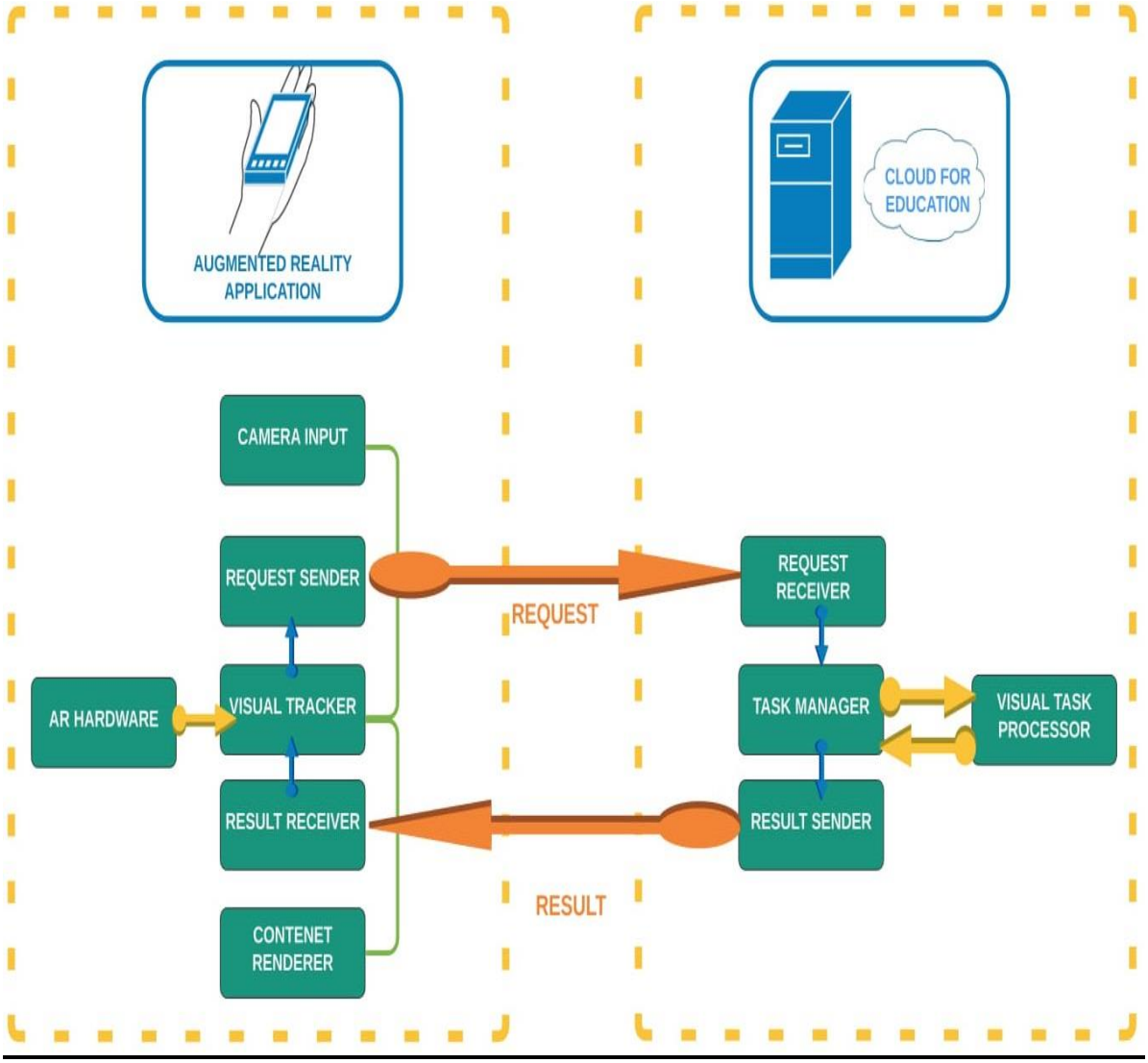


Figure 6: Augmented Reality using Cloud Education System Framework

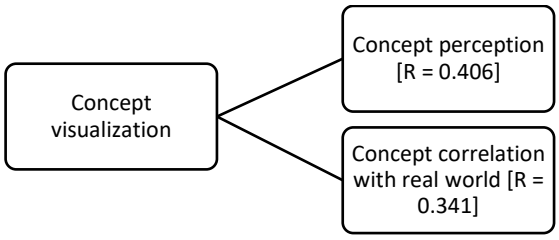
Expected Outcomes:

The finding indicated that; Concept perception, Concept correlation with the real world, Interactive, Concept inferential, and interpretation are variables associated with Critical thinking. Further, it can be well perceived that AR-based cloud education is helping both male and female students achieve Critical thinking significantly. Hereby AR-based STEM education has the potential to reduce absenteeism and increase interactive. Also, this kind of learning induces better concept learning and interpretation. Moreover, these learning methodologies are helping students apply there learned concepts in the real-world creating a useful application and implication, which is a soul moto of the teaching. Therefore, there being many conventional and modern methods in teaching, an AR-based cloud education system found to be significantly useful from the opinion collected and analyzed.

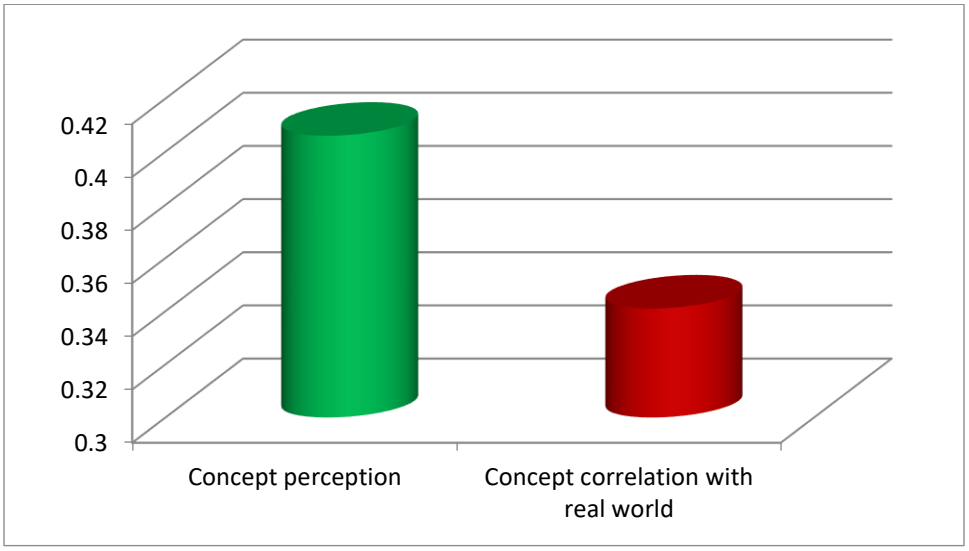
8. Performance Metrics Representation

8.1 Concept visualization:

Horizontal Hierarchy:

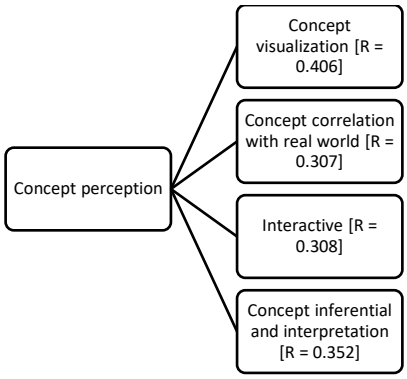


Bar Chart:



8.2 Concept Perception:

Horizontal Hierarchy:



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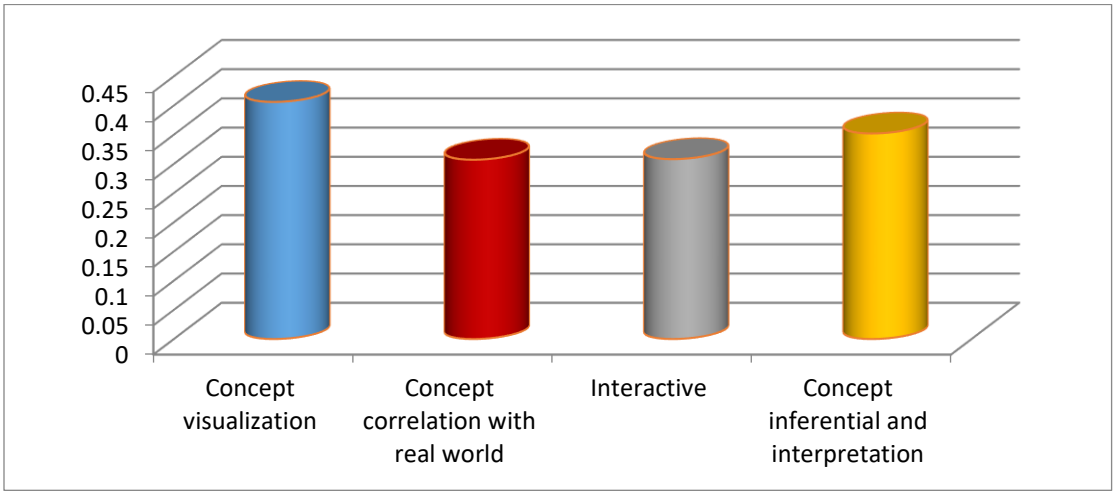
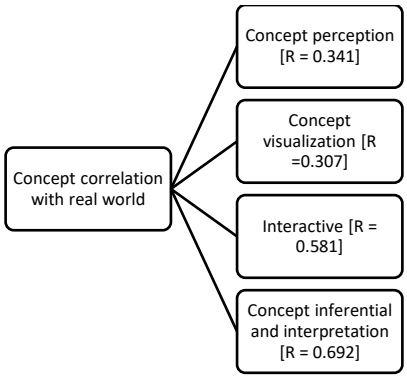


8.3 Concept correlation with the real world:

Horizontal Hierarchy:



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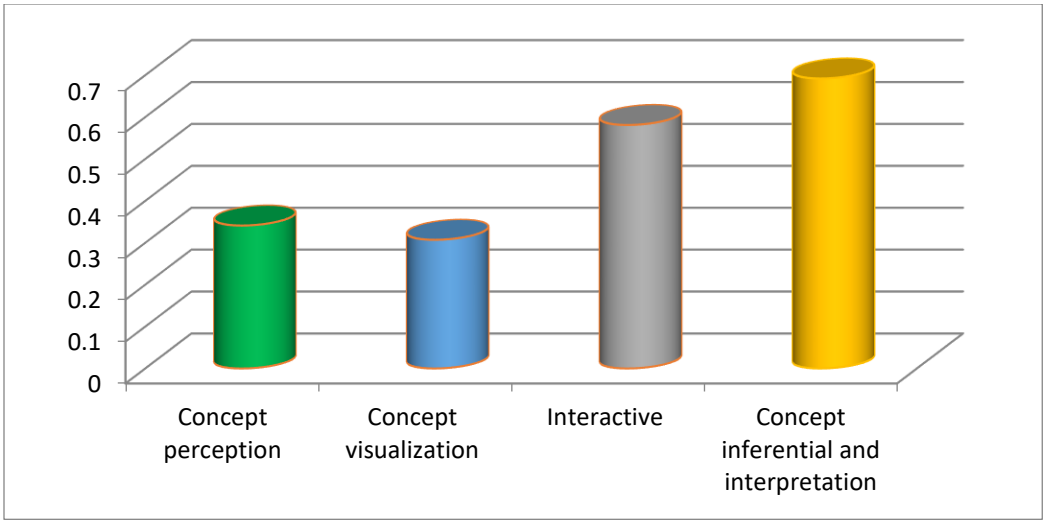
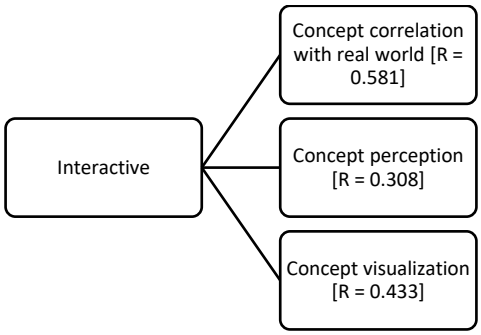


8.4 Interactive:

Horizontal Hierarchy:



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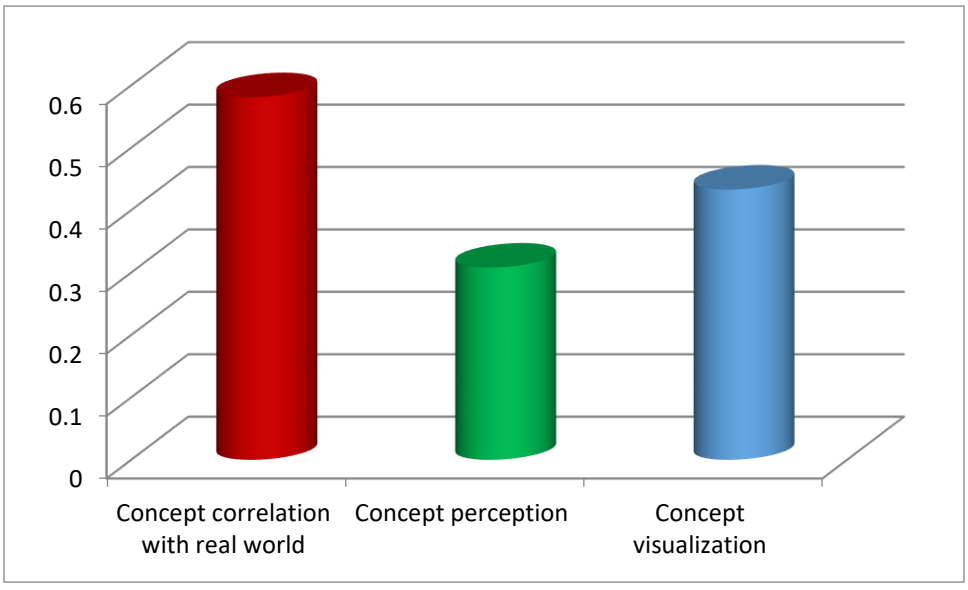
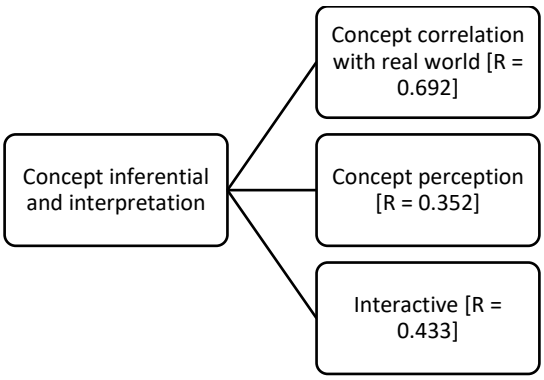


8.5 Concept inferential and interpretation:

Horizontal Hierarchy:



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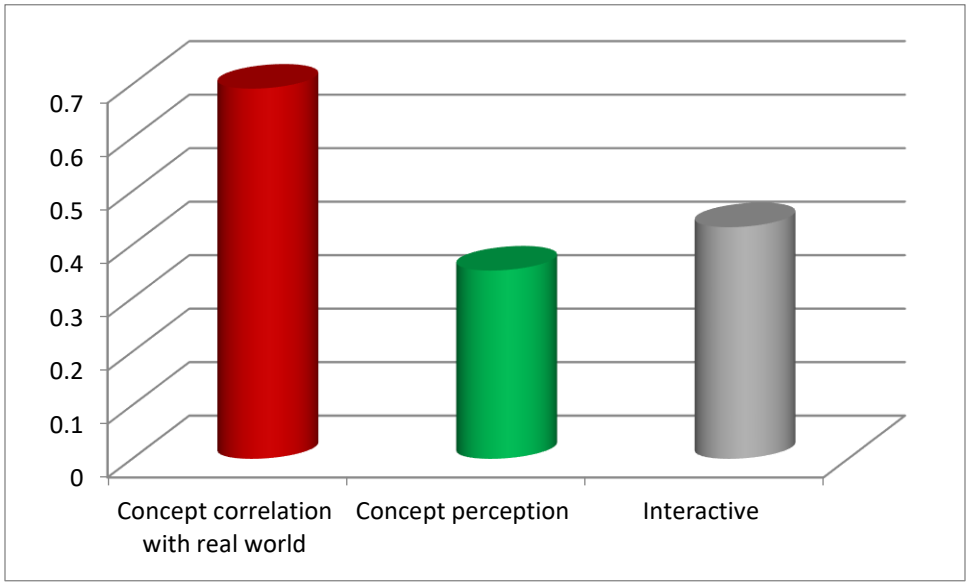

9. Conclusion

From the Cronbach's Alpha Statistics it was found that all the variables named; Concept visualization, Concept perception, Concept correlation with real-world, Interactive, Concept inferential, and interpretation are reliable. Also, the study indicated that both male and female respondents agree that the augmented reality-based cloud education system is helping them better visualize, perceive, interpret and correlate it with the real world than other conventional and traditional teaching methods in STEM concepts. Further, it was identified that Critical thinking of students is strongly and positively correlated with Concept visualization, Concept perception, Concept correlation with real-world, Interactive, Concept inferential, and interpretation. It can be still a long way from cheap VR technology that will completely in the virtual world. But as the whole world realizes the shortcomings of video, it looks like there will be a drive for better VR and AR technology in the future. Thanks to COVID-19, it now knows the value of being in someone else's place, at least believe.

Conflict of Interest Statement:

The authors declare that they have no conflicts of interest to report regarding the present study.

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