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Evaluation of Augmented Reality Implication in the Education Sector

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Abstract

The education industry is identified as the most vibrant industry and welcomes advanced technology to elevate its teaching and learning process. The new recent technology of augmented reality (AR) is robustly implemented in the education industry. The educator's perspectives toward the applications and implications of this augmented reality are studied in this paper. It is proposed to evaluate the expectations of the educators from the implementation of AR in the education sector and the outcome experienced from those applications, the derived experiences, and the increased level of excitement and engagement of the educators and learners. A causal research design is adopted to study the cause and effect of the implication of AR in the education field, and the data is observed from 450 users of AR in the education field, in Bangalore city using the five-point Likert scale. The collected data is coded, tabulated, and processed through SPSS V.22, and the necessary structural Equation model is built through AMOS V.21. It was concluded that for paying attention to the cost structure, method of utilization, the chance of development of content relevant to their field, easy accessibility and developmental programs availability, and its approachability, etc. wholly determine the implications of AR in the field of the educational industry.

Keywords: *Augmented Reality, AR, Education, ICT, learning, Technology, Virtual Reality.*

1. Introduction

Education is an evergreen field that admits new and advanced technology in its teaching and learning process and it is evidencing the evergreen transformation through the adoption of various advent technology tools in the learning platform. One such kind of transformation that recently happened is the implication of Augmented Reality (AR) particularly in education. There are plenty of benefits drawn from the use of AR technology in Teaching and Learning, immersive practical experience, interactive learning system, quick access to learning tools, no special requirements of hardware, improved collaboration technologies, three-dimensional presentation of information and content, engaging students and giving them immersive experience to the learners, since AR superimposes multimedia contents such as videos, sounds and graphics onto present

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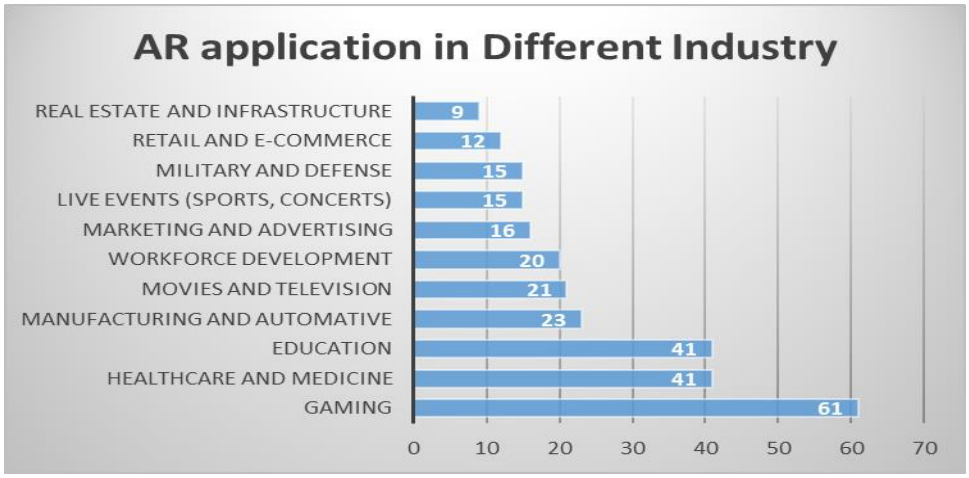
environment. AR uses four main elements to superimpose images on present environments: i) cameras and sensors, ii) processing, iii) projection, and iv) reflection.

Recently many giant technology scalable business model enterprises have invested huge amounts in emerging technologies like VR and AR to whisper the benefits to their empowered customers (Korolov, 2014; Ebert, 2015; and Castelvecchi, 2016). Some of the companies are Google, Samsung, Sony, and High Tech Computer (HTC) Corporation. Among VR and AR, AR technology has a more modern application history as claimed by various research pioneers in their research (Cipresso and Serino, 2014; Wexelblat, 2014). Augmented Reality technology enhances the perception of reality by integrating computer-generated objects and virtual content into the real world (Hugues, et al. 2011). Azuma et al. (2011) provide three commonly accepted criteria that denote AR systems as systems that have three components namely linking real and virtual, real-time interaction, and register in three dimensions as designed by Zhou et al., (2008).

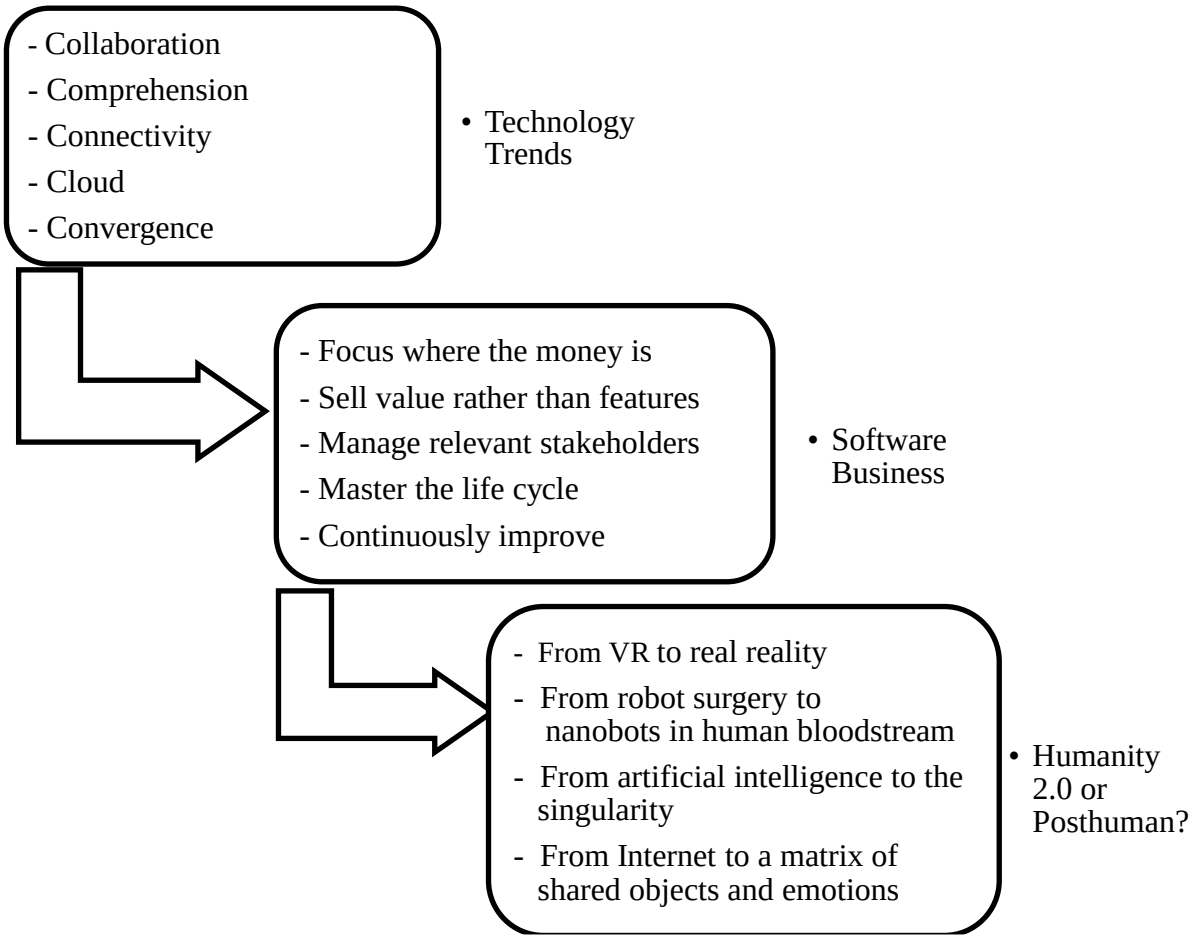
Based on the application scenario of AR technology in the recent past, the industry-wise application was surveyed by the Perkinscoie, 2019-Augmented and virtual reality survey report (2019) by XR Association about the Augmented and Virtual Reality application by including as many as eleven industries in the survey which is using the AR technology in an outreached manner such as hospital and medical, education, production and automotive, marketing and advertising, e-commerce and m-commerce retail, film industry, employee workforce, gaming and live events such as sports, concerts, defense, real estate and infrastructure development. The Figure 1 exhibits the amount of utility of AR technology by each respective industry mentioned here.



(Source: 2019 Augmented and Virtual Reality Survey Report)

Figure 1. AR application in different industries

It was crystal clear and quite obvious that the application of AR technology is trending in the Gaming industry followed by healthcare and medicine and the Education industry (41%) as per Figure 1. It is the need of the hour, to study the adoption rate of AR technology among educators in the field of education industry. This paper intends to study the same.



(Source: Ebert, 2015)

Figure 2. AR transition - The way forward

The advancement of technology is evidenced through rapid transformation in the software business and make the reality situation in their day-to-day life (Ebert, 2015). Humanity 2.0 or it is addressed as post-human in engaging humans or the extended reality in the working environment deliberates the importance and need for the present study. It illustrates the transition (Figure 2) from virtual reality to actual reality, from artificial intelligence to singularity, from robot surgery to nanobots in the human bloodstream, and from the internet to a network of shared objects and emotions. Users are always expecting extreme utility and satisfaction from the advent of technology. AR technology is nowadays implemented in the education sector also proven the replacement of tutorials with real reality and augmented reality technology. The AR supports explaining problems and issues, complicated theories, and difficult concepts with pictorial, animation, and explored videos with illusion. It simplifies the work of teachers in explaining the concept and sometimes it elevates the better understanding level and long-lasting knowledge. This study also embarks on the practical implication of Augmented Reality in the education sector from the educator's perspective. It covers the benefits and outcomes earned through the implementation of Augmented reality technology in the education sector.

2. Statement of the Problem

Technology advancement is immensely taking place. The adoption of technology is a prerequisite for the sustainable development of any industry. In the education sector, the

standard of education is necessarily improved to give more knowledge and a better understanding of fuzzy concepts in an easy and visual reality is one such technology diffusion, which will enhance the users' learning ability with an immersive experience. At this juncture, the need to study the level of influence of this technology enforcement on the learning platform is raised. To fulfill these requirements, the current study is proposed to exhibit the users' expectations and the outcome reality of their tech-savvy learning experience.

3. Literature Survey

Different researchers all over the world underline the implications of various technologies in different industrial environments, especially here concentrated more on the education industry. Yakubova, et al. (2021) have undergone research to highlight the intervention of Augmented Reality (AR) with autism spectrum disorder (ASD) technique and Intellectual and Developmental Disabilities (IDD) in the field of teaching academic skills to the students' community. It portrayed the information about the participants of these technology innovations, AR interventions, and many other extravert strategies to execute the intervention, skills, and other unique characteristics in it. The findings of the study narrated that the interventions of augmented reality with ASD and IDD were not made any significant influence to meet the specified criteria which are classified under evidence-based practice in teaching academic skills to students' fraternity. Omer and Huseyin (2019) discussed the usage of Augmented Reality in teaching and learning environments and also analyzed the association between perceived usefulness, approach, utility, and educational accomplishments. Also, the study focuses on the extensive use of augmented reality in the field of accomplishments in teaching and learning and its effect. The results of the research highlight that there is a strong positive effect on perceived benefit based on the AR application in educational environments; a positive influence on the ease of attitude levels and perceived benefits. It was observed that there are no semantic relationships between academic achievement and level of attitude and the practice of AR applications in the education field in spreading academic excellence to students.

Cipresso et al. (2018), Wu et al. (2013) and Bohil et al. (2011) observed how the primary areas of application for virtual reality have changed over time, as well as how widely VR is being used. The studies also focused on the increased advantages and challenges of augmentation, and its effects also be focused on through their study. It was concluded in the study that considering the disruptive contribution that Virtual Reality /Augmented Reality will be able to get in various areas such as scientific fields, human communications, and interactions in the area of mobile phone applications among people. Schmitz et al. (2012) summarize the multiple reviews of literature about the research field of AR-based games for education from a range of disciplines. These AR games consist of mobile technology, and geo-specific gaming activities with the advent of augmented reality content. The findings of the study explain the extensive applications of augmented reality games in the field of education and substantiate the motivational potential and the possibility to enhance and evidence towards knowledge acquisition.

Guttentag, (2010) emphasized the vital applications of Virtual Reality (VR) in the tourism sector and it attracts the greater attention of researchers and professionals working in the field of tourism. It is obvious that the number and significance of such applications undoubtedly will increase in the tourism sector with the evidence of the continuous evolution of VR technology. The area covered with the application of VR technology in the tourism sector involves planning and management, entertainment, education, accessibility, marketing, and heritage preservation to prove the value additions. Burdea, et al. (1996) studied the multimodal interactions with computer-simulated applications through visual, auditory, and haptic feedback with the advent of Virtual Reality (VR)

technology. In this research especially they reviewed the standardized aspects of various input-output devices consisting of trackers, 3-D audio cards, stereo displays, sensing gloves, haptic feedback masters, and so on. It further evolved the significant impact of utilization of these state-of-the-art facilities and devices in offering the local cum network distributed virtual reality simulation systems effect and registers the positive effect on its application in the relevant field.

The research gap identified for the current study is explored in three different ways, the implications of augmented reality were not explored in the education sector from the users' perspective, so the concept of the study is naval in this area. The geographical gap identified through the current study is, this kind of research is not been exist in the education sector, especially in Bangalore City. The methodology and application of tools for constructing the Structural equation model for the impact of augmented reality in the education sector are identified as a contextual gap for this study.

4. Research Objectives

The following are the objectives developed to study the impact of AR in the education sector based on different stakeholders' perspectives on experiencing augmented reality.

- To study the features of augmented reality (AR) in the education sector.
- To understand the expectations of users about augmented reality in the education sector.
- To evaluate the outcome determination from the usage of augmented reality in the education sector.
- To analyze the influence of augmented reality experience on the excitement and engagement level.

5. Research Hypotheses

The study objectives are tested through the following null hypotheses.

- Expectation towards augmented reality does not influence the experience of the users
- The outcome of augmented reality does not influence the experience of the users
- Experience gained through augmented reality does not mean improving the excitement and engagement level of the users in the education sector.

Amos V.21's structural equation modeling and confirmatory factor analysis are used to evaluate the aforementioned hypothesis. The model constructed is presented below and the same depicts the various expectations towards augmented reality followed by the outcomes generated from it, and the experience built through the usage of augmented reality and the contribution towards the development of excitement and engagement level of users in the implication of augmented reality in the education sector.

6. Research Methodology

The causal research design is adopted, based on the expectations of the users and the derived outcome after the diffusion of augmented reality technology in the education sector. The study also focused on the effect of the implementation of augmented reality in the education sector on the users' excitement and engagement level. The data required for the study is observed from 450 users of augmented reality in the education sector in

Bangalore city using the five-point Likert scale for evaluating their expectations, outcomes, experience, excitement, and level of engagement with augmented reality technology in their teaching and learning pedagogy. The collected data is coded, tabulated, and processed through SPSSV.22 and the necessary structural Equation model is built through AMOS V.21.

The current study included only as many as 450 respondents from educational institutions located in Bangalore city only. The opinion given by the respondents is purely personal in nature, so it is subject to personal Bias. The study is testing the impact of augmented reality in the education sector, so the results may or may not reflect in the same way for the other sector of the education sector in other cities.

7. Analysis and Discussion of Augmented Reality in the Education Sector

Augmented reality is an upcoming technological revolution happening in various industries, education is no exception thereto. The implication of augmented reality will bring more than the virtual reality experience in the classrooms. The users might have all the chance to experience the objects in 3D technology, to have a better understanding and proper explanation. There could be no need to estimate or imagine the features or configurations or applications or constructions or internal structure of any machines or human anatomy or globe or construction building of any automobile or computer and Nanotechnology platform. Because augmented reality enhances the users to take the picture or images of the object to study and automatically with the help of the encyclopedia or any other search engine, the 3D model of the objects will be ready and the same can be exported and presented to the needy. It will give away the simulation experience to the user one who cannot experience the same in the real world like space research, medical research (Carolien et al., 2014), and any other complicate model which is too expensive to construct and abolish both in economic and ecological means.

The technology diffusion in the education sector is quite inevitable and it is rapidly increasing the application and adoption by the stakeholders in the education sector because the benefits derived from the implications of augmented reality are vivid. The experience gained by using augmented reality in the education sector was narrated by different users in a different format but ultimately it develops the enthusiasm towards the users and improves their engagement level with the advanced technology to increase their knowledge and comfort in accessing the information, moreover, the excitement level also be increased vibrantly due to better and quick understanding of the concept with three-dimensional visual presentations. To test the level of excitement and engagement of the users belonging to Bangalore city who are experiencing augmented reality in their classrooms both in an online and offline mode based on their expectations towards the augmented reality and the outcome they gained by using the same, the Structural equation model in this study was constructed using the CFA (confirmatory factor analysis) with Varimax rotation. For the model development under the CFA, the defined set of factors under expectations and outcomes are used by referring to various research studies and working papers.

The recursive structural equation model for the impact of augmented reality in the education sector was constructed by using forty-eight different variables altogether, among that twenty-three variables are observed and endogenous variables, are directly observed from the data collection tool structured questionnaire and the other twenty-five variables are unobserved or exogenous variables among them twenty-three are residual variables and two variables are composite variables for the observed variables in the model. The influence of expectations towards AR and the effect of the same on the experience gained using AR followed by the influence of experience on the level of excitement and engagement level derived from the usage of augmented reality in the education sector. The following measurement model is explaining the relationship

between the variables and the same was exhibited through the arrow marks the observed variables are depicted through the rectangle boxes and the latent variables and residuals of the observed variables are exposed in ellipses form. The covariance between the factors is displayed in double arrow marks and the covariance of the variables is determined through the modification indices under confirmatory factor analysis. The changes given for the further modifications are evaluated logically and examine the applicability of the statistical results before establishing the covariance between the recommended factors and necessary incorporation was made in the measurement model to improve the indices for the final structured model of augmented reality in the education sector.

The statistical results of confirmatory factor analysis (CFA) present the indices of goodness of fit index (GFI) and adjusted goodness of fit index (AGFI). In order to validate the constructed model along with the Root mean square error of approximation (RMSEA) and Root Mean Residual (RMR), the study also used the indices of comparative fit index (CFI), and Tucker-Lewis Index (TLI) The chi-square value is highly volatile concerning the sample size; hence these indices are claimed by many researchers to prove the validity of the model (Kenny & McCoach, 2020). Even researchers like Kenny et al. (2015) claimed that the fit indices should not be computed for small degrees of freedom and small sample sizes. Since the sample size is adequate and large for this study, this model can be validated with the help of fit indices as indicated by Tanaka, J.S. (1987). The model establishes the power of covariance in the SEM built on the recommendations of the modification indices because the covariance also influences the contribution of one factor on the other towards the construction of latent variables as pointed out by Satorra and Saris (1985) and Sharma, et al., (2005).

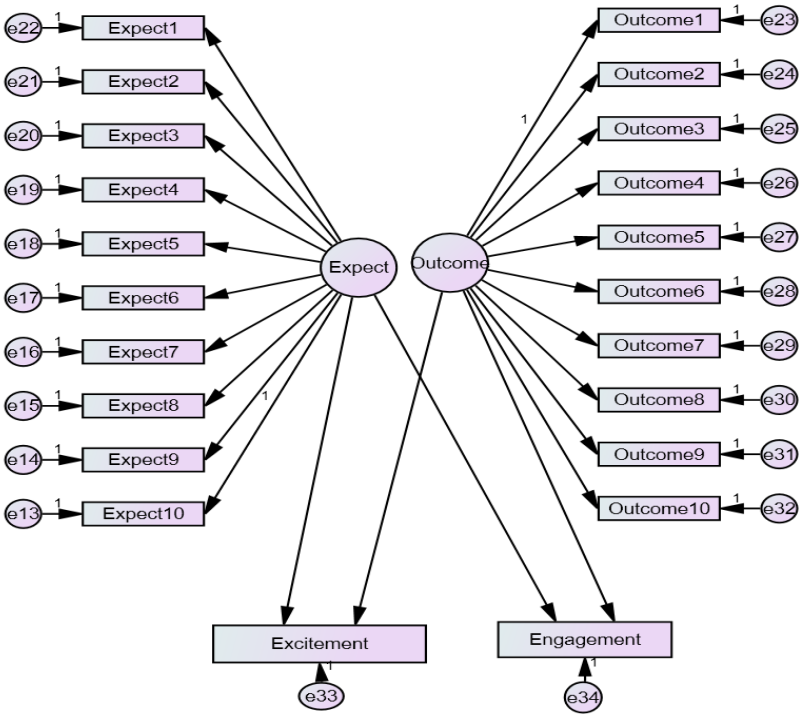


Figure 3. Measurement model for the Impact of Augmented Reality in the Education Sector

Based on the outcome of the measurement model for the impact of augmented reality in the education sector, there is a need to add the mediating variable to boost the orderly influences on the excitement and engagement level of the users of augmented reality in the education sector. Thus, it is decided to assess the experience of the users as the mediating variables, through which the improvement in the users' excitement level by

using augmented reality in education and the extensive engagement derived by the users after using augmented reality in education in terms of better understanding, quick access, more information, visual presentation, ease of access and endurance of learning. The experience gained by the users is immersive and the effect also influences them to spend long hours using augmented reality in a different area where the complications are more and required further clarifications with simulations and hands-on experience. The final structural equation model establishes covariance and introduced the mediating variable experience to enhance the good fit of the constructed model.

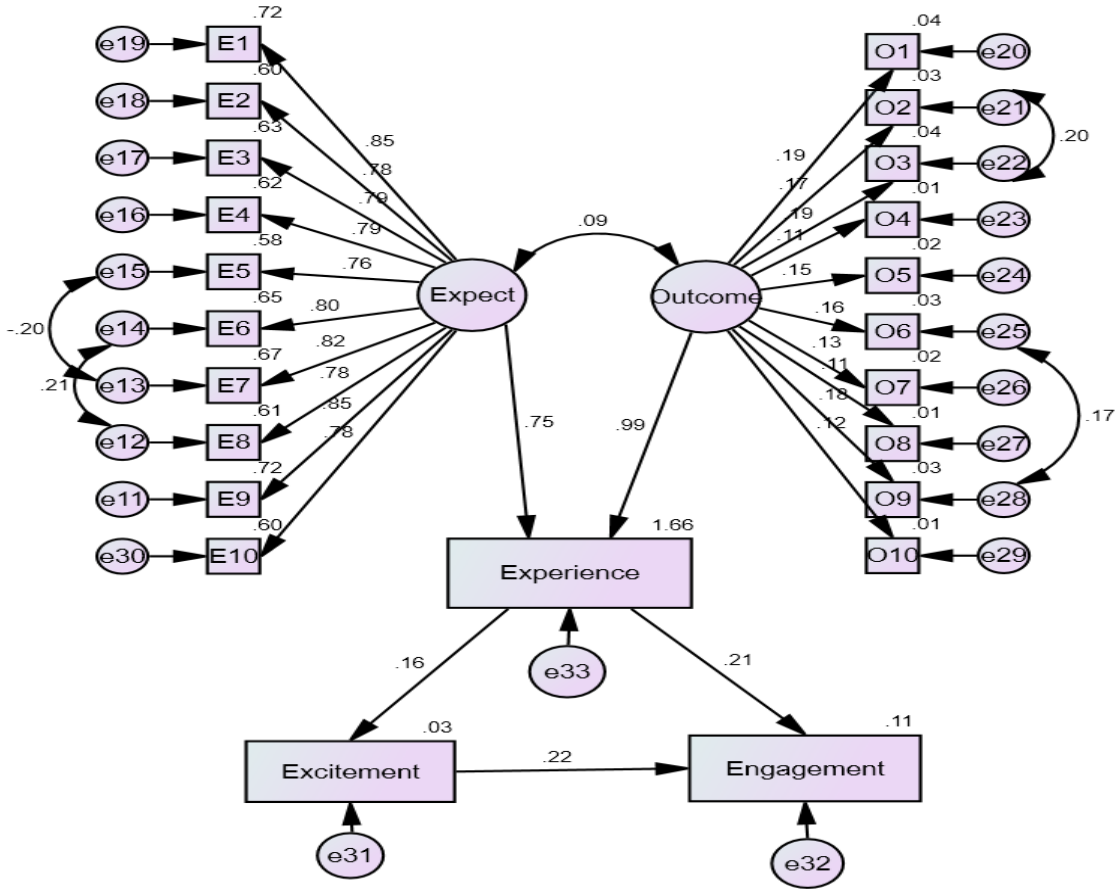


Figure 4. Structural Equation Model for the Impact of Augmented Reality in the Education Sector

The structural equation model is developed by using the CFA and the test result of the statistics are displayed Table 1.

Table 1. Confirmatory Factor Analysis Results

Statistics	Test Results	Accepted Norms
CMIN	922.728	
DF	223	
P	.000	<.05
CMIN/DF	4.138	
GFI	.969	>0.9
AGFI	.938	>0.9
CFI	.959	>0.9

TAG	.939	>0.9
RMSEA	.024	<.05
RMR	.059	<.06

It is observed from the results of CFA the model is in good fit. The outcome of GFI, AGFI, CFI, and TLI support the model with the desired level and the RMSEA and RMR values also produce statistically significant result. With all the statistical values and logical explanations, the model can be claimed as a good fit.

The contribution of each factor towards the construction of the structural equation model is explained through the estimate values and significant statistics ($p<.05$). There are ten variables loaded to explain the Expectation of users towards augmented reality in the education sector, they are Better sensation of size and perspective (.959), More practical than theory (.837), High Interactivity (.842), Encourage creativity (.768), Inspire empathy (.825), Stimulate interest (.903), Learn from mistakes (.922), Self-guided exploration (.839), Add value by answering questions (.820) and Create novelty immersive experiences. The outcome variables were also measured with the help of ten observed variables, they are Faster learning, Better Understanding (.778), Develop Excitement (.967), Expand learning experience (.557), Improve learning outcomes (.666), Enhance student engagement (.783), Eliminates Time Location and language barrier (.664), Higher research scope (.520), Recreate in-person experience (.908), and Increase efficiency (.571). These variables are grouped into Expectations and Outcome variables and their respective contribution towards gaining the experience from augmented reality is measured at first level, and the experience is used as a mediating factor to measure the users' excitement and engagement in using the augmented reality in their education platform. The contribution of expectations towards the learning experience through augmented reality is measured as 75% and the outcome towards the learning experience is measured as 99%. It shows the learning experience is highly influenced by outcomes more than the expectations of augmented reality. The users explore the immersive experience in terms of usage and the individual outcome they derived from it irrespective of their expectations of applications of augmented reality in the education sector.

Table 2. Estimates for the Impact of Augmented Reality in the Education sector

Variables			Unstand-ardised. Estimate	Standa-rdised Estimate	S.E.	C.R.	P	Result
Experience	<---	Expect	.476	.753	.063	7.557	***	
Experience	<---	Outcome	3.419	.985	1.209	2.828	***	
Excitement	<---	Experience	.189	.164	.054	3.518	***	
E9	<---	Expect	1.000	.849				
E8	<---	Expect	.839	.778	.041	20.273	***	
E7	<---	Expect	.922	.818	.042	21.973	***	
E6	<---	Expect	.903	.805	.042	21.396	***	
E5	<---	Expect	.825	.759	.042	19.487	***	
E4	<---	Expect	.768	.790	.037	20.768	***	
E3	<---	Expect	.842	.794	.040	20.947	***	Rejected
E2	<---	Expect	.837	.777	.041	20.234	***	

Variables			Unstand-ardised. Estimate	Standa-rdised Estimate	S.E.	C.R.	P	Result
E1	<---	Expect	.959	.850	.041	23.511	***	
O1	<---	Outcome	1.000	.191				
O2	<---	Outcome	.778	.170	.150	5.173	***	
O3	<---	Outcome	.967	.188	.178	5.445	***	
O4	<---	Outcome	.557	.112	.137	4.071	***	
O5	<---	Outcome	.666	.146	.138	4.823	***	
O6	<---	Outcome	.783	.161	.156	5.030	***	
O7	<---	Outcome	.664	.131	.146	4.531	***	
O8	<---	Outcome	.520	.111	.129	4.048	***	
O9	<---	Outcome	.908	.176	.172	5.285	***	
O10	<---	Outcome	.571	.121	.133	4.287	***	
E10	<---	Expect	.820	.777	.041	20.233	***	
Engagement	<---	Experience	.238	.211	.051	4.685	***	
Engagement	<---	Excitement	.218	.224	.044	4.953	***	

The model also explains the level of excitement and engagement of the users based on their learning experience, it explains that the influence of experience to excitement is only 16% and experience to engagement is 21%. Based on the statistical significance results, the null hypotheses are rejected for all the cases, and proved that expectations and outcomes do contribute towards the learning experience of users through augmented reality in the education sector; the learning experience does influence their excitement and engagement level to a certain extent.

Thus, it is concluded that the learning experience is not adequate to enhance the greater excitement of the users and at the same time to increase their level of engagement in the augmented reality technology infusion in the education sector. The users are expecting a lot more experience in different areas of their learning, they need more practical cum visual presentations to keep long-lasting memory rather than theory aspects. Much more implications are also required to treat the users' excitement and improved experience, and the more content and concept offered through augmented reality will make them engage more hours together in the learning platform, it gives a different experience and even satisfaction in their teaching-learning pedagogy. The engagement also deeply be disturbed by the number of concepts, theories, and other problems converted and presented in augmented reality form.

Practical Implications

Under the present scenario in the study area, the implications of augmented reality are an upcoming technology trend, especially in the education sector, slowly the stakeholders started to adopt the technology infusion in their regular courses, but at the same time, very few courses only being offered with the help of augmented reality. By providing enough awareness cum hands-on training experience for widespread applications of augmented reality in their teaching-learning pedagogy, it will contribute more towards the learning experience and emerge as an immersive technology at an affordable cost. The users who have already used augmented reality and had little experience with an adequate

amount of excitement are supporting the increased level of engagement (22%). The level of engagement based on calculated statistics from the derived model is not too satisfactory, it can be further increased by establishing more learning platforms using augmented reality and creating rapid awareness in this field. Concerning the speedy adventure taking place in the technology sector, the implications of technology in education also should be expanded, necessary measures should be taken to implement this futuristic technology in the education sector to improve its scale of standard in Outcome-based Quality education.

8. Conclusion

Augmented Reality enables a collaborative, universal, and extended learning platform for learners equally around the globe. It assures a great sense of presence, and an immersive experience to learn the most complicated concepts with the animation effect. In the education sector, the implementation of Augmented reality is an emerging area of application, the education sector always accepts and evolute towards advanced technology adoption. Especially in the younger generation, the students as well as educators are much inspired by augmented reality technology and its implementation in the education field. But the cost structure, method of utilization, chance of development of content relevant to their field, easy accessibility and developmental programs availability, and its approachability, etc wholly determine the implications of augmented reality in the field of the educational industry.

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