Adopting Augmented Reality (AR) Technology to Enhance the Quality Education: Moving Towards Sustainability Goal 4

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Abstract: Education is the main key to obtaining human potential and the growth of the country. It takes a prominent role in the individual life cycle. To meet the current global requirements, there are various changes taking place under the agenda of the new education policy 2020-2021. The New Education Policy has given special attention to vocational studies, digital learning and problem-solving methods.

The agenda of Sustainable Development Goal 4 (SDG4) for 2030 desires to obtain equitable access to quality education and lifelong learning opportunities for men and women. The SDG4: Target 4.4 aims to extensively grow the number of youth and adults who have relevant abilities, including technical and vocational talents, for employment, first-rate jobs and entrepreneurship.

To enable quality education, there is a need for incorporation or awareness of required subjects in all education fields such as Data Science, Machine Learning, Artificial Intelligence, Virtual Reality and Augmented Reality etc.

Augmented reality in education enables students to maintain complex information in visual form. Via augmented fact, educators/ teachers can educate more successfully, resulting in better interactivity and engagement. For instance, with augmented reality, beginners can elevate their creations, collaborate, and efficaciously clear up difficult concepts.

This study aims to understand the perception of teachers towards the use of AR applications to create educational content and their willingness to adopt the same in the academic curriculum to enhance the quality of education. For the purpose of this study, training was given, and the consequent experience of AR-aided teaching was recorded to realise their perceptions. PUC government and government-aided science teachers from Dakshina Kannada and Udupi Districts took part in the study.

Keywords: Sustainable Development Goal, SDG4, Quality Education, Augmented Reality (AR), New education policy.

1. INTRODUCTION:

Education globally is one of the important sectors to witness progressive reforms at present times. India has a proud heritage where education is treated with profound veneration. Ancient Indian education was based on a Gurukul system where the teacher who was referred to as the Guru would give training in language, philosophy, as well as in household activities to his shishya or students at the Gurukul. The Gurukul was a place where the teacher used to instruct students in all activities and give subject and household knowledge. In the 21st century, education is witnessing a constant evolution as a result of the virtual revolution taking place across the globe. The quick development in Information

Technologies (ICT) has brought remarkable changes in the country.1. Shapley et all. (2011), technological, communication, and informational skills required for 21st-century learners have transformed the core requirements of students who attend school. The desired skillset along with required experiences, and learning styles has shifted considerably from before. Methods of teaching and the use of teaching aid has been reshaped based on convenience, requirements and with current trends. ICT is turning out to be increasingly significant in our day-to-day routines and in our educational systems.

In India initiatives like Digital India has served to transform India into a digitally empowered society and knowledge-based economy which is attempting to reduce the digital divide. According to the Digital Indian Government report (2021), India has the fastest rate of growth of digital adoption after Indonesia. India's digital index score has risen from 17 in 2014 to 32 in 2017. Similarly, the rate of growth of mobile internet access has witnessed similar appreciation. Notably, even the lowest income state Uttar Pradesh has rapidly moved to the highest subscriptions to the internet which is filling the inequality resulting from the digital divide in the age of technology.

Emerging technologies are reframing teaching and learning. 2.Pierson (2001) says integrating technology in the curriculum is helping in elevating the quality of teaching. Teachers are also trained and skilled to use computers in ways that may help in enhancing the teaching and learning experience. The Indian UNICEF case study report says, teachers are pivotal to the overall development of the child. Teachers must be provided with all necessary teaching tools and training to successfully perform their duty. Teachers require continuous support, training, and access to technology so that they are able to create digital content suitable for enhancing the learning experience. Teachers have to build the capacity to communicate through technology and deliver quality education. Karnataka conducts unique programs to train the teachers with ICT, digital innovation for students, technology-based programs, computer-assisted learning programs, and technology-assisted learning programs to train the teachers to use technology towards the mission of digital India.

2. (Pierson 2001), Educators must use innovative methods to communicate the concepts to students. Teaching is student-centred to make teaching effective teachers must shift the focus from regular class activity-based teaching and need to use emerging technology aid for the individual learning needs.

Education is the origin for sustainable development. Sustainable development goal 4 emphasizes on equal access to quality education and lifelong learning and improving the facilities and creating safe environment. 3. Salde (2017) Education is not just delivering content rather it is helping children to become productive citizens. 4. Madani (2018) quality education refers to teaching strengths like school infrastructure, quality equipment, material, resources skill development and equal education.

To meet the sustainable development goal, equitable quality education educators need to adopt the emerging technologies to create and communicate the concepts to students. 5.Carolyn A (2003), adoption of technology is based on system factors, technology factors, social factors, use of factors, and audience factors. EM Rogers in 1962 developed the Diffusion of Innovation Theory, which speaks about how technology or an idea spreads over a period. Adoption of a particular technology or an innovation, is influenced on the basis of a number of factors which include- the Relative advantage of the innovation, the Compatibility of the technology for use, Complexity, Trialability, and Observability of the results of the innovation. These factors influence whether an individual or a society will find it conducive to adopt the concerned technology. In the Education Sector, technology is becoming a significant resource for creating and sharing content with students. Augmented Reality (AR) is one of the booming technology which could be used to create educational contents that can also allow teachers to communicate better with the students using AR content.

Augmented reality is overlaying computer-generated objects into the physical world. AR permit using 3D dimensional objects, images, videos, text, and animation collectively combine digital data with the real world at the identical time. Augmented Reality not only combines digital data with the real world, but it also interacts and portrays the digital data in 3D dimensions. AR applications can be used on different devices like Smartphone, Laptop and wearable technologies like Smartwatches. AR technologies can be used with any Smartphone to adopt the AR technology for educational purposes without the requirement of any additional equipment.

This study aims to know the teacher's willingness to create educational contents using AR technique and to promote the implementation of AR technology in educational field to add-on to meet the goal of SDG4.

2. Literature Review - Augmented Reality (AR) in Education

Tom Caudal coined the term Augmented reality in 1992. Initially, AR technology could be experienced with the help of a head-mounted display, which was primarily used for aircraft and military purposes. With the advancement of technology, AR use has been enabled on a variety of platforms, including desktop computers, laptops, tablets, and smartphones. Additionally, AR can be experienced on a VR headset with the passthrough mode. 6. Softtek (2021),

presently, the use of AR technologies can be supplemented in various ways. This is done through two primary categories namely, Marker-based and Markerless AR.

7. Saidin et al., (2015), Augmented Reality application is used in different domains like Astronomy, Biology, Entertainment, Geography, History, Manufacturing, Mathematics, Medical, Military, Physics, and Scientific sectors among others. 8. Sotiriou & Bogner (2008) Converging AR technology in education is challenging because technology is expanding and getting more attention in other sectors which is also creating opportunities for entrepreneurs and teachers to create meaningful educational experiences. Many experimental studies have been conducted to check the effectiveness and feasibility of using AR Applications in the domain of education.

9. Kesim and Ozarslan (2012) study provides an overview of augmented reality (AR) technology used in education. 10. Bulbul et al., (2016), study speaks about applications that can turn a smartphone into a physics laboratory for blind students. Teachers who don't have access to physical laboratories could demonstrate experiments using their smartphone. The use of QR code Augmented Reality is one of the components that can be added to the Physics virtual lab. To study with the help of such virtual labs, the students can download free smartphone applications from the google play store which can read the QR code markers and help students navigate generated scenarios. Such applications are also being enabled for the use of applications by blind users. 11.Smith et all. (2016), a study was conducted focusing on the improvement of navigation skills of students with different intellectual disabilities by using Augmented reality. An iPhone application was used to do the experiments regarding improvement of navigation skills on the university campus which yielded largely positive outcomes. To know the effectiveness of problem-based learning in Physics with marker-based AR technologies, 12. Mustafa & Tuncel (2019), conducted a study in north turkey with 91 students from the seventh grade. Early-age students found it difficult to understand the abstract and complicated concepts of Physics. In order to find ways to reduce the challenge and make Physics easily understandable, this study was conducted by using two experimental groups and one control group. A quasi-experimental research design was used for the experiment. Semi-structured interviews were conducted to know the student's opinions on using AR applications. The study suggests that AR is more useful and creates positive attitudes towards learning the concepts of Physics. The study concluded with the finding that integrating AR into education is an effective and essential tool that can be utilized to solve Physics problems.

13.Sotiriou & Bogner (2008), Museums and digital technology assume a significant role in facilitating lifelong learning for a wide group of learners. Learning Science with Museum program was conducted to assess the effectiveness of AR in this regard. A museum visit was conducted with an experimental and regular group students. Both the groups explored the museum during the visit, but the experimental group was also made to experience the museum along with science content with AR technologies whereas the regular students group experienced the museum through an orthodox tour. The outcome of the student's learning experience was measured based on the group performance post the visit. The observed outcome of the study suggests that connecting regular educational experiences with the concept of AR technology provides additional value to science learning. To know the quality and benefits of using Mobile Augmented Reality (MAR) for educational purposes, 14. Herpich et all. (2019), conducted a study by referring to systematic Analysis of 57 articles, on the MAR approaches in the educational settings. It was observed that many studies were conducted without scientific evaluation and research design. The study also says that it required a uniform and systematic evaluation method for MAR approaches. 15. Abas & Zaman (2011) noted that understanding and re-merging stories is a difficult task for remedial students. To avoid the lack of engagement with the content, computer-based applications like augmented reality applications may be used for remedial students to assess whether they understand and enjoy the reading material. It was observed that there is a gap in the value provided by the content to remedial students. The AR Vaca-Pulin storybook was developed to fill this gap. In the process, AR books and flashcards supported the visualization of the story creating meaningful learning opportunities and helped in improving student engagement with the process.

For the study Marker less AR Application was used to train science teachers to know their perceptions about the technology and their attitudes towards adopting the technology as well as creating and demonstrating the science educational content for 11th and 12th std. science students in Mangalore, Karnataka, India.

3. Methodologies:

3.1 Data

This article is interested in knowing the teacher's willingness to adopt AR technique as an aid in educational curriculum to create contents in a more interesting way. Literature review shows that the use of Augmented reality in education has distinctive impacts on education. These studies were conducted abroad in developed countries and their contexts were significantly different from the Indian requirements. It is therefore imperative to look at the applicability

of these technologies in the Indian context. Dakshina Kannada and Udupi District are leading districts in Karnataka in terms of education. The current study was conducted using both primary and secondary data. The data was collected by introducing the TutAR application, which is an educational application launched by the Infusory future tech labs pvt. ltd. in the year 2020 during the pandemic. The content being taught in through the AR app was based on the NCERT syllabus prescribed throughout the country. The researcher used the TutAR Mobile-based Augmented reality application as a platform to train participating science teachers, especially Physics, Chemistry, and Biology teachers in Dakshina Kannada and Udupi District of Karnataka. Teachers were given hands-on training on using AR applications. The teacher's opinion before and after the use of technology was recorded by using a Likert scale questionnaire method. The research scholar spent around 8 months to give training and to collect the data for this study. Many colleges and teachers were approached for the study out of which only 105 teachers took part in the study. In each district, teachers from Physics, Chemistry and Biology departments of Government Colleges and Government-aided colleges, took part in the study respectively.

3.2 Exploratory data analysis (EDA) and Significance test

Under descriptive statistics, frequency table was charted to summarize the characteristics of the data. Pie-charts were used to represent the nominal scale data whereas the Likert scale data was represented using Stacked bar chart. Chi-square test has been used to check the significance of hypothetical statements. SPSS software was used for the analysis.

4. Discussion and Analysis :

Statistical analysis has been carried out on the data obtained using questionnaire method. Total 105 teachers from Dakshina Kannada and Udupi Districts participated in the study.

Figure 1: Stacked bar chart for Likert scale questions related to use of media technology in education.
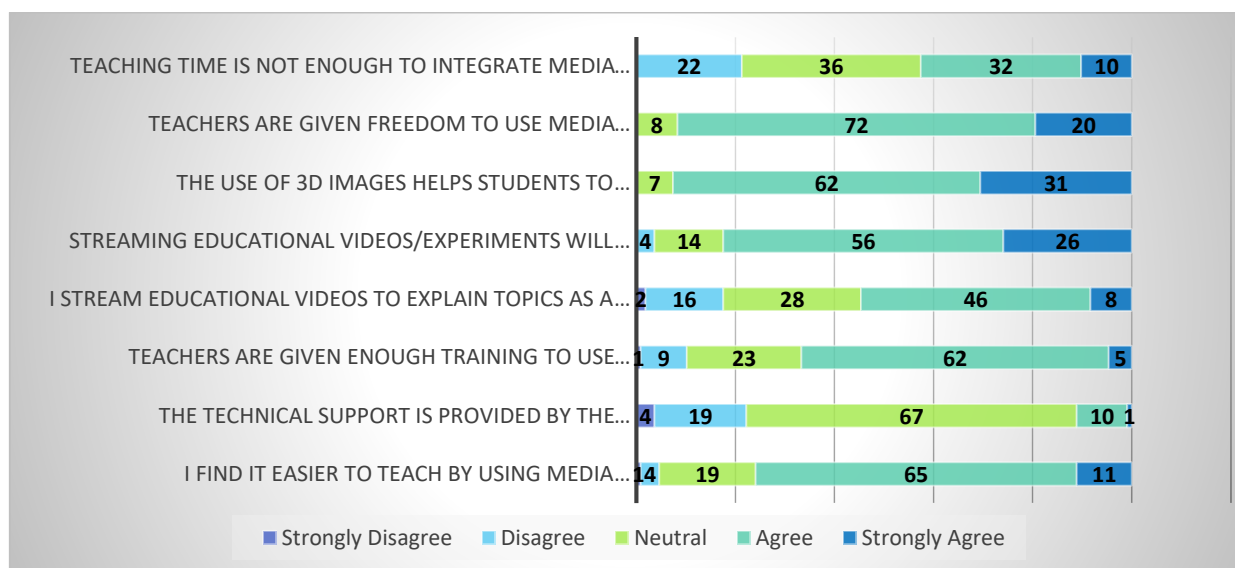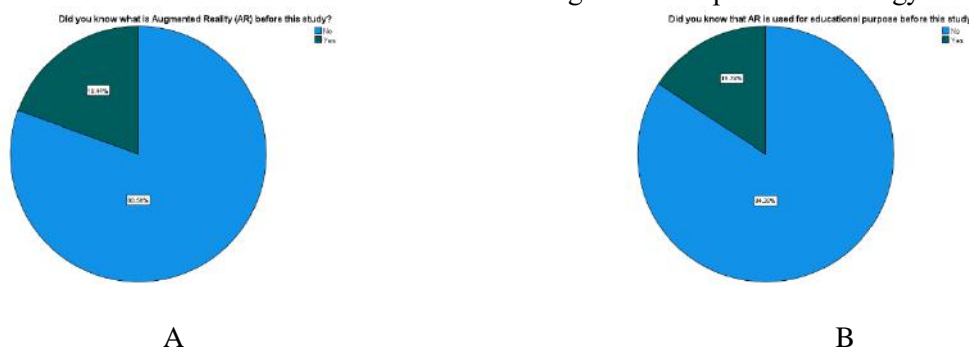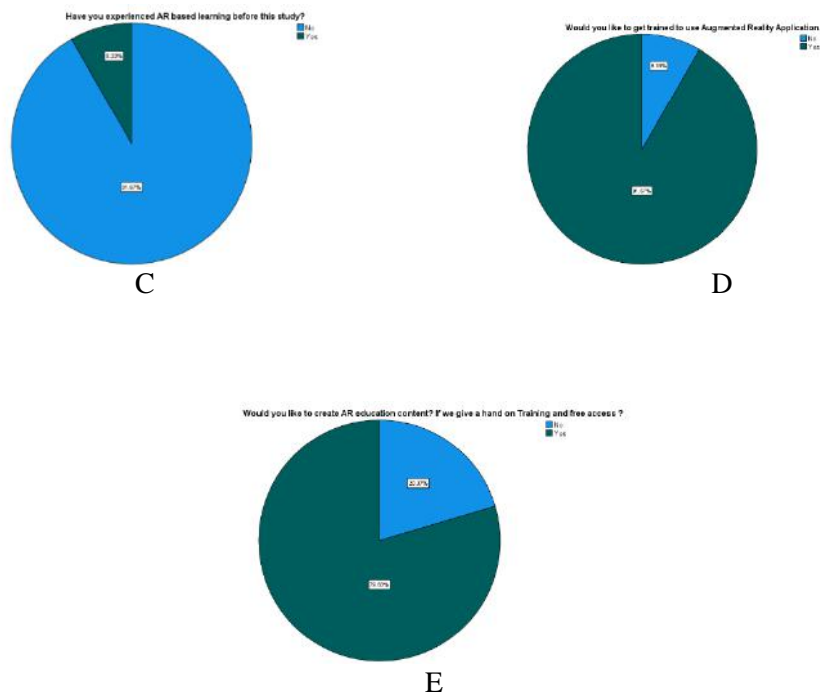

Figure 2: Pie chart on Teacher's awareness and willingness to adopt AR technology in education.

A   B

C

D

E

From Stacked bar chart (Figure 1) we can observe that, teachers are aware about use of media technology in education and 92% teachers agree that they have given freedom to use technology in education where 93% teachers agree that the use of 3D images will help students in understanding the concepts well. 67% of teachers also agreed that the institutions have provided training to use technology in education. But about 30% of teachers have noted that there is no proper technical support/assistance provided by the institutions. Pie charts from Figure 2 (a), b), and c)) show that, on an average only 10-20 percent of teachers are aware about AR technology and its usage in educational field where as 80-90 percent of teachers are interested in learning about it and adopting it to create educational contents using AR technology Figure 2 (d) and e)).

4.1 Statistical method:
Chi-square test was performed to test hypothetical statements such as,
- Whether different stream/section has any impact on lack of time to use media technology in education.
- Whether age has any impact on teachers' willingness to use AR technology in education.

Table 1:

Which subjects do you teach * Teaching time is not enough to integrate media technologies in class lecture. Crosstabulation							
Count							
		Teaching time is not enough to integrate media technologies in class lecture.					
		Disagree	Neutral	Agree	Strongly Agree	Strongly Disagree	Total
Which subjects do you teach	Biology	4	17	8	3	2	34
	Chemistry	9	12	12	0	0	33
	Physics	10	9	14	5	0	38
Total		23	38	34	8	2	105

Chi-Square Tests			
	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	22.701[a]	16	.122

Likelihood Ratio	24.832	16	.073
N of Valid Cases	105		

Table 2:

Age * Would you like to get trained to use Augmented Reality Application. Crosstabulation

		Count		
		Would you like to get trained to use Augmented Reality Application?		
		No	Yes	Total
Age	21-30	3	36	36
	31-40	3	32	35
	41-50	1	20	21
	51-60	2	11	13
Total		9	99	105

Chi-Square Tests			
	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.220ᵃ	3	.748
Likelihood Ratio	1.125	3	.771
N of Valid Cases	105		

The p-values of Chi-square test in Table 1 (p-value= 0.117) and Table 2 (p-value=0.748) is greater than the alpha=0.05 level of significance. Which shows there is no significant effect of different subjects on lack of time to use media technology in education and age have no bar to learn new technology.

Figure 3: Stacked bar chart for Likert scale questions related to teacher's perception of using AR technology in education.
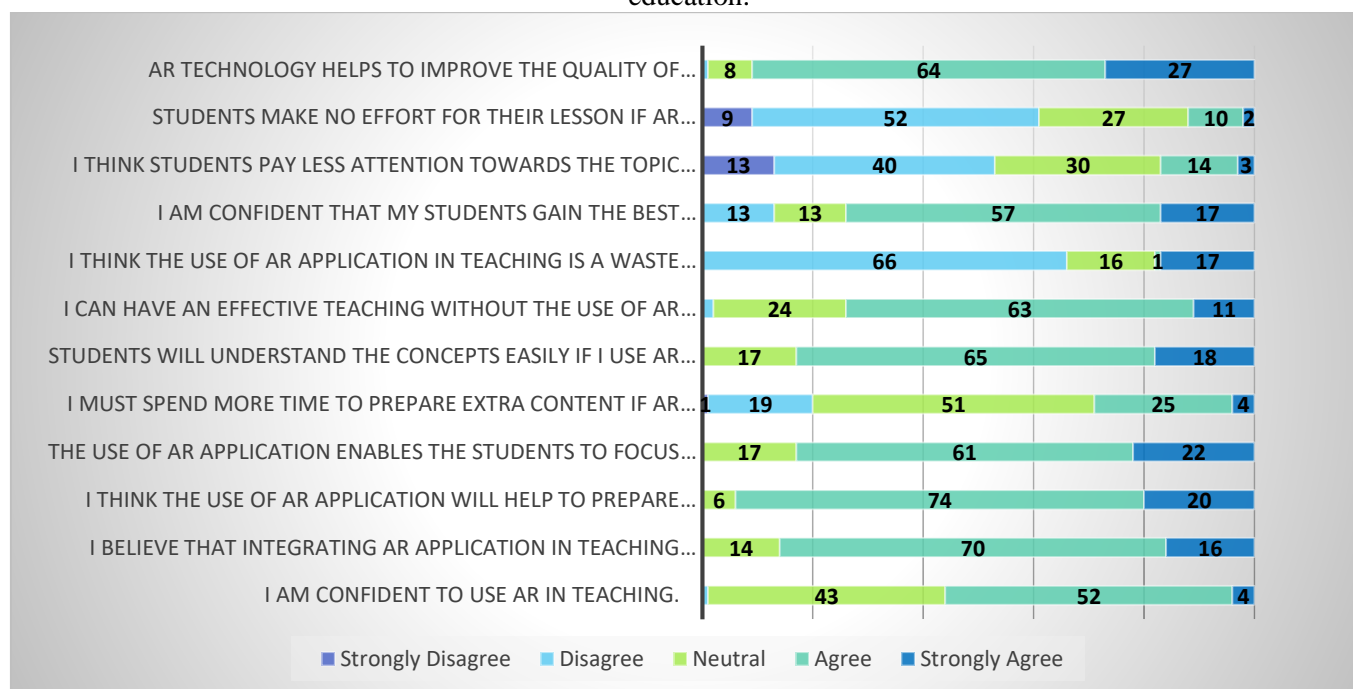
Out of 105 respondents, 99 Teachers took part in Augmented Reality Application training. This training was conducted individually in their respective institution, in the beginning, teachers were introduced to the AR technology and were given demonstration about the TutAR application by using subject-oriented animation models, and their

perception was recorded, Teachers downloaded the application on their phones to get hands-on experience. Out of 99 teachers 52% of teachers agreed and 43% of teachers were in neutral opinion and one teacher disagreed and 4% strongly agreed that they are confident to use AR application. 70% of teachers believed that integrating AR application in teaching will create a great opportunity for effective teaching. About 14% of teachers were neutral about their outlook towards integrating the technology in their classrooms and 16% strongly agreed with the statement. 61% of teachers agreed that AR enables the students to focus attentively and engage in their lessons, 29% teachers felt that they may have to spend additional time to create the educational content but 19% of teachers found the TutAR application was user-friendly and easy to use to create educational content while other teachers were of neutral opinion. 91% of teachers agreed that AR will create a good impact on education. 64% of teachers agreed and 27% of teachers strongly agreed that AR technology will improve the quality of education.

During the pandemic of the Novel Corona Virus, technology acted as the main tool in the educational field by enabling interaction between students and teachers. Teachers worked enthusiastically with technology platforms enabling distance learning to reach out to the students using online mode and to ensure that their subjects were taught with justification. This adversarial time and the experience with online mode of education has opened up new avenues for many teachers who were wary of digitalisation of the educational space. This has helped teachers to understand the need for technology integration into the educational field. Since the data for the study was collected amid the pandemic, teachers were found to be considerably more interested to learn new technologies to adopt in the pedagogy. Infact, even teachers who believe in traditional teaching methods, as well as teachers belonging to age groups (above 50 years of age) generally found to be resistive to technological changes, were found to be conducive to learning the use of AR technology for assimilating it into their teaching plans.

Mobile phones, especially the easy availability of smartphones and mobile internet service as the tool of communication for all the teachers was found to have been a contributing factor as their familiarity with the use of smartphones with various applications for communication purposes served to remove any hesitation about its adaptability. During the training phase, the researcher had to teach a few teachers to download and install the applications, but widespread knowledge of the technology made the process relatively simple to implement. Learning never ends for teachers, and also in this study it was found that age does not hinder the subject from adopting or learning new technologies. Teachers agreed that AR will improve the quality of education, if teachers get access and training to create content as well as steady technological assistance from the educational institutions, the goal of reaching and implementing SDG 4 to improve the quality of education is easily achievable.

5. Concluding Remarks :

There is a need for collaborative work between institutions, teachers, and education policymakers to reach the target of SDG4, and NEP 2020-21. More weightage should be given to implementation of technologies in all educational fields along with the proper technical support. Training students in modern technologies is need of the hour in this world rapidly moving towards complete digitalisation. It is important that upcoming technologies are adopted in the classroom productively and for this effective teacher training is imperative. Institutions must take steps to increase technological awareness among teachers and provide ample training opportunities for them to enable adoption of the AR technology as a teaching aid. Even though Indian teachers like the general populace of the country had adapted to the digital economic ecosystem in the country fairly quickly, and use smartphones and QR code readers for transactions, my study found that a staggering figure of 91 percent of the teachers interviewed were unaware of the possibility of using AR technology for educational purposes. Digital education is not only about creating E-learning programs, but also about delivering quality in e-learning, adoption of technological platforms and technology to create the relevant and engaging educational content.

Reaching individual teachers is challenging and therefore, the education sector needs to adopt the emerging media technologies in the teacher training curriculum. It is a fact that technological adaption happens naturally for many students who are exposed to these technologies in their daily lives, however, it is also factual that a large number of students remain deprived of access to modern technologies as they cannot afford it. This economic gap is resulting in widening of social, educational and digital divides. It is the responsibility of educational institutions to bridge this gap by ensuring that equitable technological access as well as advantages of AR enhanced learning is made available in the classroom. Educational content needs to be designed by using technology so that all students familiarise themselves with technology. This may help motivates learners to explore sectors which may have seemed out-of-reach. Adopting technology for creating educational content may contribute to the triple vision of modern India, namely, Digital India, Universal digital literacy in the country, accessibility of digital resources to all, and creation of digital resources in regional languages. Conclusively, the effective adoption of AR technology in the classroom may have the potential to

not only improve the quality of education, but also aligning India's vision of creating a Digital India with equal and equitable education for all.

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