EMPIRICAL RESEARCH PAPER

Vol. XIII, No. II; September 2020 - February, 2021 Print ISSN: 0975-024X; Online ISSN: 2456-1371

Impact of Learning Virtual Reality on Enhancing Employability of Indian Engineering Graduates

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Abstract

Rapid proliferation of technology during the last two decades has resulted in major changes in the nature of work. Further, the networking and automation of processes in the era of Industry 4.0 have necessitated the deployment of machines to perform routine and repetitive tasks which were earlier being handled by humans. Process automation and computerization have not only resulted in the loss of various jobs, but have also created new jobs which are technology-oriented and require relevant skills. This change in the job scenario has placed a great stress on the engineering students at undergraduate level to learn new skills in order to ensure their employability. Apart from learning contemporary technologies, the students need to possess non-cognitive skills, which will help them to deliver the demands posed by the current job challenges. The paper studies the impact of learning one such technology – Virtual Reality, on enhancing the employability of undergraduate engineering students in India. A model is proposed in the study and is substantiated through analysis of primary data collected from undergraduate engineering students in India.

Keywords: Virtual Reality, Employability, Industry 4.0, Contemporary Technologies, Learning

Introduction

India's aspiration of becoming a 5-Trillion-Dollar economy by the year 2025 is mainly fueled by three advantages which it enjoys over other countries – *Technology*, *Talent* and *Demographic Dividend* (India Skills Report, 2020). Industry 4.0 has ensured rapid proliferation of modern *technology* across sectors. Apart from creation of new jobs, it has also resulted in changing the content of the existing jobs. These changes have necessitated the acquisition of new *talent* (technical skills) by the current generation workers, for staying relevant. Apart from the above two factors, India's biggest strength emerges from its *demographic dividend*, as it has the largest number of youth in the world i.e. nearly 600 million Indians are below the age of 25. If these youths are imparted requisite technical skills, they would stand a great chance for gainful employment in both – the global and the local job markets. Nearly 1.5 million engineers graduate from about 3300 institutions every year in India. However, the placement rate is far too low, with less than 6% of them finding jobs in their respective domain areas, due to their lacking knowledge of the requisite technical skills(Sarkar, S., 2019; AICTE Dashboard). This reflects poorly on their employability skills and raises questions on the quality of education being imparted in engineering colleges. The concern became more serious when the stakeholders reported that nearly 94% of the Indian engineers are not employable, due to the *skills gaps* between the Industry requirements and those possessed by fresh engineers (India Skills Report, 2018; Shaw, K.M, 2018). However, the regulatory body, All India Council for Technical Education (AICTE) has realized the problem and

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How to cite this article: Shreenath, A., & Manjunath, S. (2020). Impact of Learning Virtual Reality on Enhancing Employability of Indian Engineering Graduates. Purushartha, 13(2), 52-62
Source of support: Nil
Conflict of interest: None

addressed it in a holistic manner, by closing down substandard engineering colleges, training of teachers in modern technologies and inclusion of these technologies in the engineering course curriculum etc.

Need for the Study:

The change in the nature of jobs resulting from the rapid proliferation of modern technologies has caused a crisis wherein technical jobs are lying vacant, but still a large proportion of the youth remain unemployed as they do not possess the requisite job skills. This issue was flagged by the industry nearly a decade ago(National Employability Report, 2011) and reiterated through various studies (Woetzel et al., 2017; India Skill Report, 2018).Thereafter, AICTE recommended that imparting knowledge of modern technologies to engineering graduates would equip them with the requisite skills and enable them to be employable in the era of Industry 4.0. Accordingly, 9 technologies were identified by AICTE, one among them being Virtual Reality (VR) (AICTE Dashboard)In this paper, the researchers have used VR as an independent variable and measured its impact on employability.

Employability

Employability of engineers is a measure of their ability to gain employment(Harvey, L., 2001) and retain it as well. In this research, the definition used for employability is based on the *skill set model*. Employability can also be described as "the possession of certain skills required for the job". A study on fresh graduate engineers in India undertaken by World Bank (Blom & Saeki, 2011)had identified the employability skills required by engineers based on past studies(Hill & Petty, 1995; Paranto & Kelkar, 2000)as well as the graduate learning outcomes laid down by the National Board of Accreditation (NBA). A total of 26 skills were identified and further grouped into three – Core Employability Skills, Professional Skills and Communication Skills.

- The *Core Employability Skills* mainly represent the personal characteristics like – Integrity, Reliability, Teamwork, Willingness to learn etc. These characteristics are generic in nature and apply to all kinds of jobs.

- The *Professional Skills,* also referred to as technical skills denote engineering-specific skills like Problem-Solving, Creativity, System Design, Application of Technical knowledge etc. These skills are job/sectorspecific and are also referred to as specific skills.

- The *Communication Skills* pertain to the ability to communicate and also to proficiency in using computers. A combination of Core Skills and Communication Skills is also referred to as *Soft Skills*.

The above categorization of skills also conforms to Bloom's Taxonomy(Bloom, 1956) which classifies learning into the following three domains:

- *Cognitive Skills*, which concern the development of knowledge and intellectual skills.

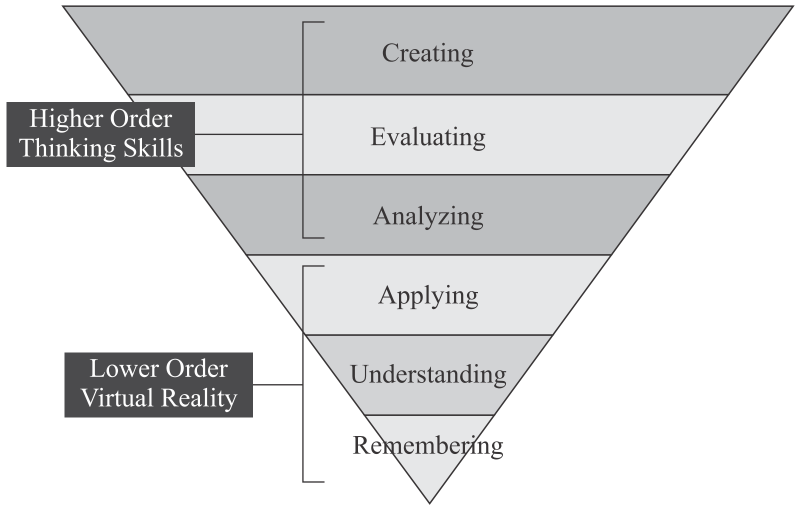
- *Affective Skills* deal with feelings, emotions, values attitudes, motivations and enthusiasm.

- *Psychomotor Skills* pertain to coordination, movements and motor skills.

Professional skills correspond to the Cognitive domain and the Core skills pertain to the affective domain. But the Communication skills are not restricted to any single domain in Bloom's taxonomy. The study also refers to Bloom's revised taxonomy and further divides the cognitive skills into two groups – Higher and Lower Order Thinking Skills:

- *Higher Order Thinking Skill*s include the three uppermost cognitive skills i.e. Creating, Evaluating and Analyzing.
- *Lower Order Thinking Skills* include three lowest-level cognitive skills i.e. Understand, Apply and Remember.

Fig. 1: Bloom's Revised Taxonomy



Virtual Reality

Virtual Reality is a digital technology, which enables the user to visualize a virtual environment through 3-Dimensional graphics and also lets him interact with this virtual world. Accordingly, this virtual environment responds to the user's actions and gives him a feel of being in a real environment with visual and sound effects. The user's feel can be further enhanced through added dimensions of smell and taste (Mazuryk & Gervautz, 1996). The technology is known by various names –cyberspace, artificial reality, synthetic environment, synthetic environment, simulator technology or virtual worlds (Onyesolu & Eze, 2011).

The thought process towards Virtual Reality (VR) was first triggered when Morton Heiligdesigned and created a non-interactive multisensory simulator - *Sensorama* in 1962 (Heilig, 1962), using a pre-recorded colour film with binaural stereophonic audio, further enhanced by scent, wind and vibration effects. The actual idea of VR was proposed by Ivan Sutherland in 1965, which included force feedback, interactive graphics, sound, smell and taste (Sutherland, 1965). Thereafter, Ivan went further to design the first VR hardware – the Head Mounted Display (HMD), which had an adaptive stereo vision capable of tracking head movements including position and orientation(Sutherland, 1968). This was followed by a series of inventions including GROPE – a force-feedback based VR system in 1991, an Artificial Reality system in 1975, an advanced flight simulator in 1982 and the Data Glove and Eyephone, VR devices for commercial use in 1985 (Mazuryk & Gervautz, 1996).

Essentially, a VR system uses a computer to create a perception of an imaginary environment through an interface between humans and computers. Hence, a human can manipulate the environment in real time through his hand-gestures which are tracked by his glove; accordingly, the user witnesses a corresponding variation in the 3D image generated in his HMD. Therefore, the key dimensions of VR are threefold – *Interaction*, *Autonomy* and *Presence*, i.e. the user experiences his presence in an autonomous environment and is able to interact with it too (Zeltzer, 1992).

Job opportunities in VR:

Engineers having knowledge in VR can find job opportunities in the field of entertainment, gaming, developing simulators for simulating a hazardous job environment and for training of doctors, astronauts and soldiers (Mazuryk & Gervautz, 1996).

Major Components:

A VR System creates a man-machine interface with the primary objective of letting humans interact with the computer, for visualizing a simulated 3D environment (Isdale, 1998). The system has two main sub-systems – *Hardware* and *Software*. The hardware includes displays, sensors, input devices and tracking systems. The software components include the modeling module, sound module, graphics module and the simulation software.

Working Principle:

The 3D image of the virtual environment is presented to the user on the Head mounted display (HMD) or any other display device (*output*). He in turn interacts with the environment through gestures like eye movements, hand movements, tilting or turning of the head etc. These are considered as stimulus to the computer. His movements are captured through various tracking sensors (*inputs*) and are sent back to the computer (*processor*), thereby altering the environment according to the stimuli received from the user. All these changes have to take place on a real time basis, without any perceivable delay, so that the system appears seamless to the user. The visuals combined with stereophonic audio give a realistic immersion into the virtual world, to the user. The system is further classified into three types, based on the level of immersiveness into the system – *Non-immersive*, *Semi-immersive*, and *Immersive* VR systems (Onyesolu & Eze, 2011).

Skills required for VR Engineers:

From the above insight into the technology, it is evident that the engineer who works with a VR system should have an in-depth *knowledge of geometry* (for constructing virtual spaces), good *knowledge of virtual hardware and software systems*, as well as be able to *integrate the various sub-systems* including man-machine interface. He should also be able to *develop full-fledged VR systems* to suit the demands of the user. His skill in these areas will help him design a good VR system and also to work proficiently with the system and thereby satisfy the user's requirements effectively. The above parameters were kept in mind while carrying out our current study.

Proposed Model

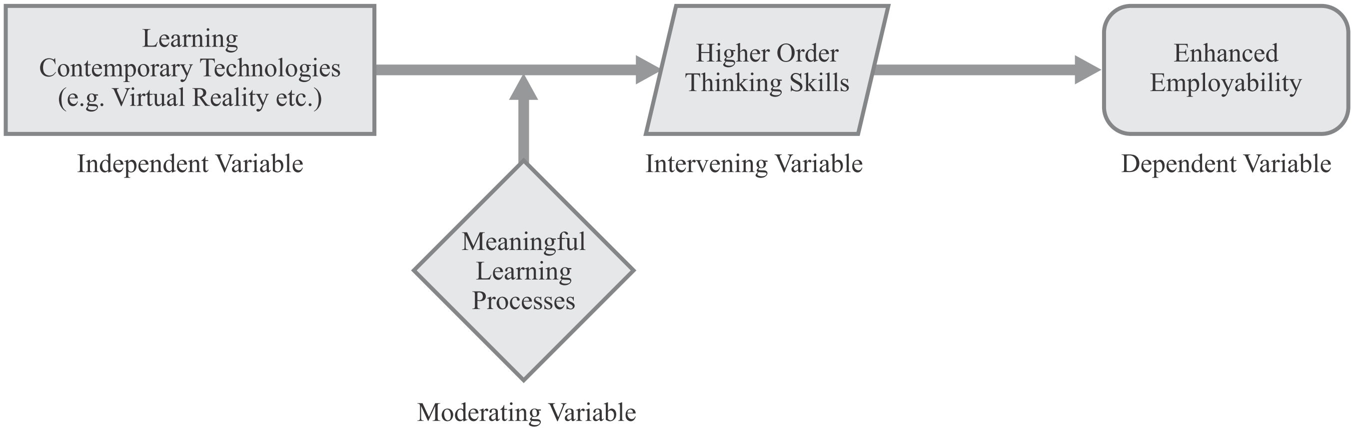
Objective of the study:

Our overall objective is to study the impact of learning VR on enhancing employability of engineering graduates.

Model Used for the Study:

For this study, we have developed a model, where we consider knowledge of VR technology as the independent variable and Employability as the dependent variable. The learning process is used as a moderating variable and the Higher Order Thinking Skills are used as the intervening variable. This relation between variables is represented as a flow chart given below.

Fig. 2: Model developed for the study



Adapted from: Sekaran U.(2009)

A questionnaire was used for assessing the knowledge-level of students in VR, using the following learning outcomes specified by AICTE in their model curriculum (AICTE Dashboard):

- Understanding of Geometric Modeling (VR1)
- Proficiency level in Virtual Hardware and Software (VR2)
- Ability to develop Virtual Reality Applications (VR3)

The self-perception of the students regarding the above three technical attributes was measured using a 5-point Likert's Scale.

Mapping of Variables:

Our current work is based on the World Bank study referred to in Section II above (Blom & Saeki, 2011). We have mapped the technology (VR) learning outcomes (independent variables VR1, VR2 and VR3) to the corresponding employability skills (dependent variables) based on the skills required for acquisition of the corresponding outcome and further classified it into higher/ lower order thinking skills, at table–1.

Table 1: Mapping of VR learning outcomes to employability skills

Learning Outcomes of Virtual Reality	Employability Skill required	Dimension of the Employability Skill	Cognitive Level
Understand Geometric modeling (VR1)	Willingness to learn	Core Employability Skill	Lower Order Thinking Skill
Study about Virtual Hardware & Software (VR2)	Advanced Computer	Communication Skill	Lower Order Thinking Skill
Develop Virtual Reality Applications (VR3)	System Design to needs	Professional Skill	Higher Order Thinking Skill

From the above table, it emerges that variables VR1 and VR2 contribute towards Lower Order Thinking Skills whereas VR3 contributes towards Higher Order Skills.

Hypotheses:

Our overall objective was further sub-divided and translated into the following three alternate hypotheses for the study: -

H1: *Knowledge of VR contributes positively towards enhancing employability*

H2: *Knowledge of VR contributes positively towards developing Higher Order Thinking Skills*

H3: *Students' technical proficiency meets the skill levels expected by the employers*

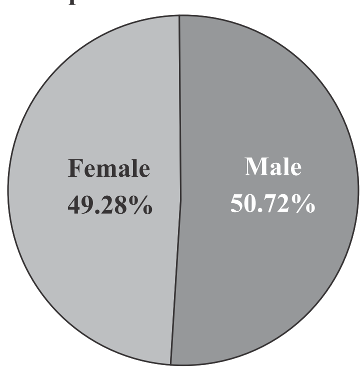
Sample Design:

The study is exploratory in nature. For the purpose of this research, samples were collected by administering a questionnaire to the students of engineering colleges who were pursuing their graduation in their respective disciplines, across India. Data was collected from colleges located in Urban, Rural as well as Semi-Urban areas. Random Stratified Sampling technique was adopted for collection of samples. A total of 412 valid responses were received.

Demographics:

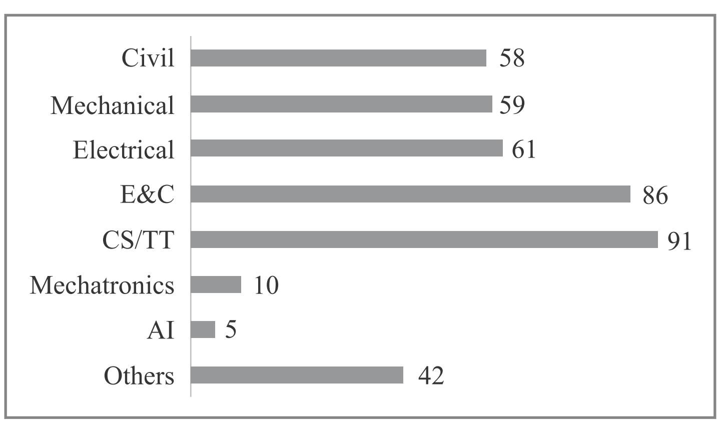
The samples were well distributed across various demographic factors i.e. gender, year of study, stream of study and the age of the respondents. The data collected contained 50.72% men and 49.28% women.

Fig 3: Respondents' Gender distribution



The samples taken were spread across seven major streams and a few other minor streams like Biotechnology, Bio-medical, Aeronautical, Instrumentation etc., which were grouped as 'Others'

Fig 4: Respondents' streams of study

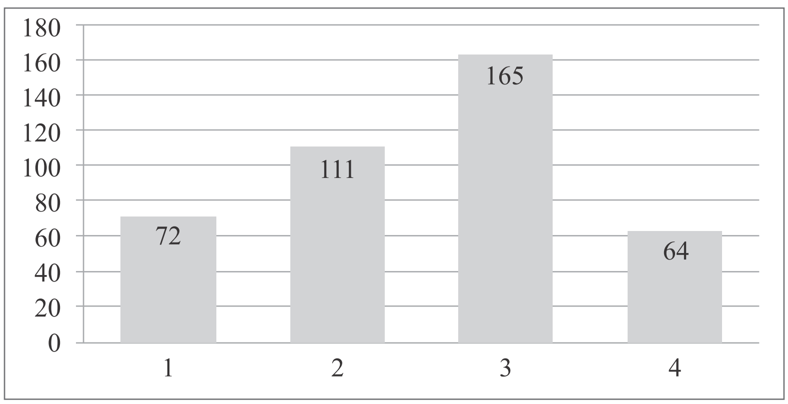


The age of the respondents ranged between 18 and 25 years. The age distribution of respondents is shown at figure 5.

Fig 5: Age profile of respondents

The spread of the samples across the years of engineering study is shown in figure 6.

Fig 6: Year of study of respondents



Data Analysis and Interpretation

The data collected was analyzed using the SPSS software. In order to ascertain the internal consistency of each of the variables used for the study, a reliability test was carried out. It was found that all the three variables were meeting the required criterion, with an Alpha (α) value of 0.703. Hence all the variables were retained, having been declared acceptable.

Table 2: Results of Reliability test

Reliability Statistics		
Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
.703	.703	3

Statistical Testing of Hypothesis

As all the three variables had cleared the Reliability Test, further analysis was carried out on them, using a one-way Analysis of Variance (ANOVA) test. The results are shown at table 3.

Table 3: Results of ANOVA test

ANOVA[a]						
Model	Sum of Squares	df	F	Mean Square	Sig.	
1	Regression	133.709	44.570	3	2.707E+16	.000[b]
	Residual	.000	.000	408		
	Total	133.709		411		

a. Dependent Variable: Employability
b. Predictors: (Constant), vr3, vr1, vr2

Hypothesis 1:

The results of the ANOVA test yielded an F-Value of 2.7 x 10^{16} which is far higher than the acceptable value of 2.696 at a significance level of 0.05; hence we reject H0 and accept H1, thereby concluding that VR technology as a whole contributes positively towards enhancing employability.

Our results are aligned with the work of (Storen &Aamodt, 2010) which quotes that "the *benefits and usefulness* of any study programme can be assessed through the students or graduates' point of view. If the students are of the opinion that the programme is good, it can be converted into their ability to start a work, for performing work tasks and for future career". Thus

Table 4: Results of Regression analysis

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.554E-15	.000		.000	1.000
	vr1	0.333	.000	0.371	95489537.15	.000
	vr2	0.333	.000	0.408	93878777.41	.000
	vr3	0.333	.000	0.477	109352782.9	.000

Hypothesis 2:

From the results of the statistical test, it is evident that variable VR3 has a relatively high Coefficient Beta value of 0.477, which implies that the students are comfortable in developing VR applications; thereby establishing that their capability to meet the "*System Design*" needs is high. This observation reflects that they have very high professional skill, which implies that the students are of the opinion that their Cognitive Skills of *analyzing, evaluating & creating* of Higher Order are high compared to Lower Order thinking towards the VR Technology.

Similarly, we observe from the results that the item VR2, which measures the students' perception towards their "*Study about virtual hardware and software*" has a Coefficient Beta value of 0.408 which is second highest in the model summary followed byVR1, which measures the students' "*Understanding of geometric modeling*" with a coefficient beta value of 0.371. The results can be interpreted as that students' *Applying, Understanding & Remembering skills* of Lower Order Thinking are comparatively lesser than their Higher Order Thinking towards the VR Technology. Hence, we reject H0 and accept H2 (i.e. *Knowledge of VR contributes positively towards developing Higher Order Thinking Skills)*.

Our findings are very much in correlation with the revised Bloom's Taxonomy (Anderson & Krathwohl, 2001), which specifies that high professional skill indeed helps build the Higher Order Thinking of engineering students (Blom & Saeki, 2011).

The findings also indicate that the person's ability towards integrated thinking and action occurs on tasks that are relevant and meaningful (Moy, 1999). “This happened because of the contribution from the active approaches of teaching and learning methods to develop generic attributes of the students. Generic attributes play a significant role in improving quality assurance of the students” (Hager & Holland, 2007). Thereby, we can conclude that the students are not only able to get a job, but also sustain the job through the knowledge of VR, as his generic attribute has been improved, along with development of higher order thinking. Overall, it will help the students to be more successful in their careers.

Hypothesis 3:

We observe from the benchmark data (Blom & Saeki, 2011) that employers' expectation towards professional skills for job performance by fresh graduates has a mean score of 3.91 which is less than the overall professional skill possessed by the students, with a mean score of 3.99.

Table 5: Descriptive Statistics

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
vr1	412	2.00	5.00	4.5558	.63498
vr2	412	1.00	5.00	4.2985	.69807
vr3	412	1.00	5.00	4.1068	.81545
VirtualReality	412	1.33	5.00	4.3204	.57037
ProfSkills	412	2.33	5.00	3.9989	.59458
CoreSkills	412	2.47	5.00	4.0339	.44519
ComnSkills	412	2.00	5.00	3.9585	.59864
Valid N (listwise)	412				

From the above results, we arrive at the interpretation that “the students’ perception about their ability to develop applications in Virtual Reality is higher than the employers’ expectation of the skill level”. Whereas the mean employer demand for the skill (μ_E) is 3.91, the mean skill possessed by the students (μ_S) is 3.99, which is higher than employers’ expectations.

i.e. $\mu_E=3.91<\mu_S=3.99$

From this hypothesis, we try to measure the students' learning motivation, which is intrinsic in nature, and also the expectations of the students from learning VR technology, which is *skills and experience* in nature (Couch & Town, 2018). From the results, it is evident that the students perceived their learning capability level on an average of 3.99 which is nearly 4 (if rounded off). On a scale of 1 to 5, with 5 being the most positive. This result can be interpreted as – the students are 80% confident about their learned skills and experience, in VR, which is much higher than the employers' expectation on students' capability. Thus we reject H0 and accept H3.

Suggestion: From the results, it emerges that the engineering students need to focus on getting jobs related to Virtual Reality technology, like development of Simulators for training in the field of Medicine (diagnosis using dummies), Aviation (design of flight simulators) business management, infant care (with simulated babies), welding (with functional computer based tools) urban planning and entrepreneurship etc. (Kaka et al., 2014).

Conclusion

The results also reinforce the fact that, in addition to utilizing the institutional resources, the students have also supplemented their knowledge by learning VR through other learning pedagogies like online learning, MOOCs etc. Thus, we observe that the efforts put in by AICTE in the terms of offering SWAYAM Courses and counting them towards the regular credits for their engineering courses, has benefited the students towards developing their employability skills.

*Recommendations:*Students should explore job opportunities preferably in simulating various applications in the fields of Medicine, Urban Planning, Entrepreneurship, Business Management, Welding sectors so as to ensure that the skills possessed help them find befitting jobs in the fields of their interest. (Kaka et al., 2014).
Conclusion: The results of the study indicate that VR contributes more to higher order thinking than to lower order thinking. This clearly highlights that the change in the educational system through reforms like teachers training, practical weightage changes and increased stress on *learning by doing* through internship has paid off well towards enhancing employability of the engineering students of India in the field of VR technology.

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