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Educators' Perceptions of the Use of Virtual Reality in the Classroom: Psychometric Validation of Scale in Indian Context

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Abstract: With ample evidence supporting the benefits of using Virtual Reality (VR) in education, teachers' perceptions of such educational innovations decide whether they are accepted or rejected and, if accepted, how successfully they are integrated into teaching. However, there is a dearth of literature with regard to the availability of a suitable measurement tool to gauge their perception specifically in the Indian setting. This is the research gap that is aimed to be met and the novelty of the study. Based on the theory of Diffusion of Innovations and the Technology Acceptance Model, the study aimed to validate Educators' Perceptions of the use of VR on Classroom scale, adapted by Khukalenko et al. (2022) from Wozney et al. (2006). The original version was tested among Russian educators and had 16 items on a six-point Likert-scale format with a Cronbach's Alpha of 1.00. The investigators here conducted the validation process on a sample of 150 Indian university educators. Because it is a relatively new scale and is based on a strong theory, confirmatory factor analysis (CFA) alone remained adequate for its validation in India. By using IBM SPSS and AMOS for data analysis, the factor structure of the initial model led to the deletion of eight items due to low factor loading values. The second model, however, suggested a satisfactory fit of this unidimensional scale with eight items and yielded a Cronbach's alpha coefficient of 0.843. It is, therefore, a reliable tool for measuring teachers' perception of the use of VR in the Indian context.

Introduction

Education is critical to every nation's advancement in civilization, politics, and economy. As a result, effective teaching is crucial and should be centered on supporting students in progressing from one knowledge level to the next (Muijs et al., 2005). However, educators encounter an extensive amount of information that needs to be inculcated, which is inadequately portrayed and lacks practical interaction from students when using conventional teaching styles, therefore enviably affecting their understanding and memorization. Efficient teaching needs to convey the relevant information in the proper modality. Effective and engaging information transmission is vital for achieving this, and visualization techniques play a pivotal role (Choudhury and Chechi, 2024). More recently, researchers have debated with the availability of newer revolutionary instructional strategies that could be integrated into the teaching arsenal and used to boost or supplement conventional teaching methods (Bakare and Orji, 2019; Sivarajah et al., 2019; Olelewe et al., 2019; Orji and Ogbuanya, 2018; Naz and Murad, 2017; Dhir et al., 2013). As a result, novel pedagogy is viewed as an assertive tactic to incorporate teaching and relevant approaches into education in innovative ways. The goal is to make the teacher serve as a mediator in reaching the specified learning objectives while learners

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are thoroughly grasping the lessons. Using new technology can achieve these goals whilst improving student results and reducing instructional time (Alfalah, 2018).

Advancements in Information and Technology (IT) enable learners to better comprehend ideas, phenomena, and theories through many means (Bakırcı et al., 2011; Kim et al., 2011; Li and Lim, 2008). Groundbreaking and interactive digital tools have transformed learning methods, providing learners with a stimulating setting to learn subjects like mathematics, language and many more (de Koning-Veenstra et al., 2014; Furió et al., 2015). According to researchers, pupils learn more effectively if they participate actively and can apply the principles to their real-life situations. Such effective learning helps students develop crucial competencies like problem-solving and analytical abilities (Voogt and Roblin, 2012). As new technologies and teaching modalities emerge, there is an increasing tendency in IT to use 3D multimedia and the web in education. One such modality is Virtual Reality (VR) technology, which has the potential to improve the education sector significantly. According to Hussein and Nätterdal, 2015, Virtual Reality combines hardware (a personal computer, head-mounted displays, and tracking sensors) and software to provide an immersive experience. VR systems are becoming increasingly popular in education these days because of their ease of use and accessibility.

Studies have demonstrated that using VR in educational contexts has several benefits (Schott and Marshall, 2018; Cheng and Tsai, 2013; Wu et al., 2013). It is well acknowledged that the employment of such ICT materials has been shown to increase learner's mindsets towards learning (Goldin and Katz, 2007; Hõrak, 2019; Lazar and Panisoara, 2018; Lieshout et al., 2018). Using VR in STEM (science, technology, engineering and mathematics), education can aid in visualising complex subjects, which in turn improves comprehension. Research suggests that employing VR in classrooms can increase student engagement and lead to better educational outcomes. This technology promotes student-focussed pedagogy active learning, improves memorization (Krokos et al., 2019), creates enjoyable classroom environments (Kaplan-Rakowski and Wojdynski, 2018; Chen et al., 2022) and reduces anxiety (Kaplan-Rakowski and Gruber, 2022; Gruber and Kaplan-Rakowski, 2020). The majority of the research reviewed found that adopting VR improved students' achievement and drive. One such research review conducted on the benefits of VR in education revealed better learning accomplishments but that it is too complicated and laborious for educators to implement it. According to Rogers (2019), VR has been dubbed "*the learning aid of the 21st century*" because of its numerous plaudits.

While VR is becoming increasingly popular, some educators are reticent to include technology into curricula fully. Mazloumi Gavgani et al. (2017) listed a few of the barriers to VR adaptation, including high equipment costs, cybersickness complaints, and heating after prolonged usage. Another impediment to VR usage in the curriculum is the absence of teacher training. Alfalah (2018) identifies inadequate time for learning how to operate such technology and the requirement to adapt old curricula to the new medium to be impediments to its inculcation. Alfalah also identified several elements that influence technology integration. These elements include (1) student and teacher perspectives, (2) support from institutions, (3) integration challenges, (4) justification for integration, and (5) prior technological experience. Exploring user-end attitudes and perceptions is crucial, particularly in the initial phases of integrating VR technology. According to Albirini, 2006, educators' opinions and attitude toward the use of instructional technology influence their adoption and effectiveness in incorporating them into education. This notion aligns with the Diffusion of Innovations theory, which says individuals' perception towards technology is critical to its dissemination (Rogers, 2010).

Previous studies highlight the significance of teachers' attitudes and perceptions about using VR in the classroom. In view of this, methodologically sound longitudinal studies are needed to gain a profound insight into this factor regarding the use of the technology (Goh et al., 2014; Sek et al., 2010; Lee et al., 2011). While few such research (e.g., Alfalah, 2018; Wozney et al., 2006) are available, there is still a lack of a standardized tool to assess this factor i.e., teachers' perception towards the use of VR technology in education, which is vital to gauge the factor under scrutiny. This is profound, specifically in India, a country that is yet to take stage for technical normalcy in education.

Theory and Background

Theory

In 1962, E.M. Rogers, a communication theorist, created a theory termed *Diffusion of Innovations*. The theory explains how different people who engage with or start using an entirely novel idea go through different stages of adoption. Therefore, it discusses how new concepts, habits, products, or technology spread throughout a community gradually. Its adoption

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commences with innovators and early adopters and progresses through the general population over time. The last to accept new innovations are termed as laggards. It goes on to state that an individual's knowledge alone does not guarantee acceptance of an invention, as attitudes also play a role throughout (Brahier, 2006; Diffusion of Innovations Theory, 1962; Parisot, 1995; Sahin, 2006).

Yet another theory that throws light on the attitude of users is Fred Davis's (1989) Technology Acceptance Model (TAM). He proposed that three elements might explain a user's desire to adopt technology: perceived ease of use, perceived utility, and attitude toward utilizing. Davis believed that while the promise of ICT to improve the educational processes is seemingly appealing (Davis, 2011), the question of learning technology rejection or acceptance may be critical. He further emphasised that a user's perception of a tool is a significant predictor of whether the user would actually utilise or dismiss it (Granić and Marangunić, 2019).

Definitions of Virtual Reality (VR)

Various definitions of VR exist in literature showcases its different understanding and growth over years. For instance, Steuer (1992) defined VR as "a real or simulated environment in which a perceiver experiences telepresence" (p. 7). Later in the same century, Schroeder stated "A computer-generated display that allows or compels the user (or users) to have a sense of being present in an environment other than the one they are actually in and to interact with that environment (Schroeder, 2008, p.25)". In 2001, two authors stated ''It is best described as a collection of technologies that allow people to interact efficiently with 3D computerised databases in real time using their natural senses and skills. It is an immersive technology'' (McCloy and Stone, 2001, p.912). Another author stated VR to be ''Simulations that use a variety of immersive, highly visual, 3D characteristics to replicate real-life situations and/or health care procedures; virtual reality simulation is distinguished from computer-based simulation in that it generally incorporates physical or other interfaces such as a computer keyboard, a mouse, speech and voice recognition, motion sensors, or haptic devices'' (Lopreiato, 2016, p.40).

Research Gap

Research highlights the significance of figuring out teachers' attitudes and perceptions about the use of VR technology in the classroom. Despite VR technology's increasing fame and accessibility, very little research has been conducted on teachers' perspectives on its use in education due to the dearth of valid scales. The objective sought to be met here is to validate the adapted version of teachers' perceptions of the use of VR technology in the classroom scale by Khukalenko et al., 2022 in the Indian context.

Review of Literature

Ismail et al., in 2010 found that teachers' attitudes, along with strong backing, both personally and from the institute, have a significant role in integrating technology in education. Similarly, their attitudes influence how technology is embraced and propagated (Sugar et al., 2004). Educator's instructional approaches- the method by which they disseminate knowledge to the learners, are shaped by their own experiences with learning, areas of expertise, and previous instructional methods (Hauer and Quill, 2011; Singh and Hardaker, 2014). Ertmer and Glazewski (2015) found that instructors' chosen teaching methods and techniques had an influence on the incorporation of technology in their classrooms (Ertmer and Glazewski, 2015). In other words, according to Wozney et al. (2006), instructors who adopt student-centered approaches use technology more frequently and are at a higher degree of integrating it.

While there have been studies on technological perception, their findings may not be generalisable to VR in specific. According to Ertmer et al. (2012), improved access to technological resources during the early 2000s has significantly reduced external obstacles such as cost, etc. However, they may still exist with emerging technologies like VR. Newer technologies may need instructors to prepare, educate, and be comfortable utilising ever-changing VR equipment. Teachers' perceptions of classroom technology may differ from their actual practice due to such challenges. According to Burch and Mohammed, 2019, new technology can lead to changes in the teaching and learning methods, creating a gap in the digital system of education due to the intricacy of staying up-to-date. We notice how such factors can shape their perception and attitude towards VR.

As per our knowledge, we noticed not more than two surveys that have explored this scenario as of 2023. One was by Alfalah in 2018, which explored it among Middle Eastern university educators who were wizards in information technology and the other by Khukalenko et al., in 2022, who explored it among a large sample of Russian educators. One of the potential reasons behind this dearth of surveys and the absence of them in India is the lack of valid scales to measure them.

Material and Methods

Study context and design

A meticulous non-experimental research design, specifically a descriptive study based on quantitative data collection, was undertaken among university educators in India. In order to choose the samples, University educators- Assistant professors, Professors and Associate professors from thirteen states of India were randomly chosen via email invitations in late 2023. The respondents were briefed on the objectives of the survey and encouraged to answer to the best of their honesty. The survey was open for participation for one month before closing after reaching the desired sample size of 150.

Details of the respondents

The samples were widespread based on location, type of institution, work experience, area of expertise, etc., to name a few, in order to retrieve a generalizable data. The thirteen states of the respondents were Assam, Bihar, Jharkhand, Uttar Pradesh, Kerala, Himachal Pradesh, Jammu and Kashmir, Maharashtra, Punjab, Rajasthan, Telangana, Uttarakhand and West Bengal. The areas of expertise included Education, Political Science, Computer Science, Agriculture, Law, Psychology, Verbal Ability, History, Geography, English, Hospitality, Sociology and Statistics. Other details are displayed in Figure 1 as data visualization.

Survey Instrument

The survey questionnaire consisted of two sections out of the three sections mentioned by Khukalenko et al. (2022) such as Section 1: Demographic information Section 2: Perceptions and use of VR technology in the classroom.

Section 1 comprised eight questions pertaining to the demographics such as age, gender, designation, location of the institution, type of institution, years of teaching experience, area of expertise and state of the institute. Also, the availability of IT personnel, the subject of utilizing VR, etc., were a few of the questions asked regarding VR. In this section, the questions were multiple-choice (MCQs) and fill-in-the-blank. Section 2 comprised 16 Likert-scale questions to gauge eduactors' perceptions of the use of VR technology in the classroom by Khukalenko et al. (2022), which was adapted from the Technology Implementation Questionnaire (TIQ) developed by Wozney et al. (2006). The Technology Implementation Questionnaire (TIQ) was designed using expectancy-value theory and consisted of 33 items organized into three major motivator categories: perceived expectancy of success, perceived value of technology use, and perceived cost of technology use. It was intended to measure teachers' practices and perceptions regarding implementing computer technologies in education. However, to customise the questionnaire for their research, Khukalenko et al. (2022) eliminated certain portions of the original survey, which

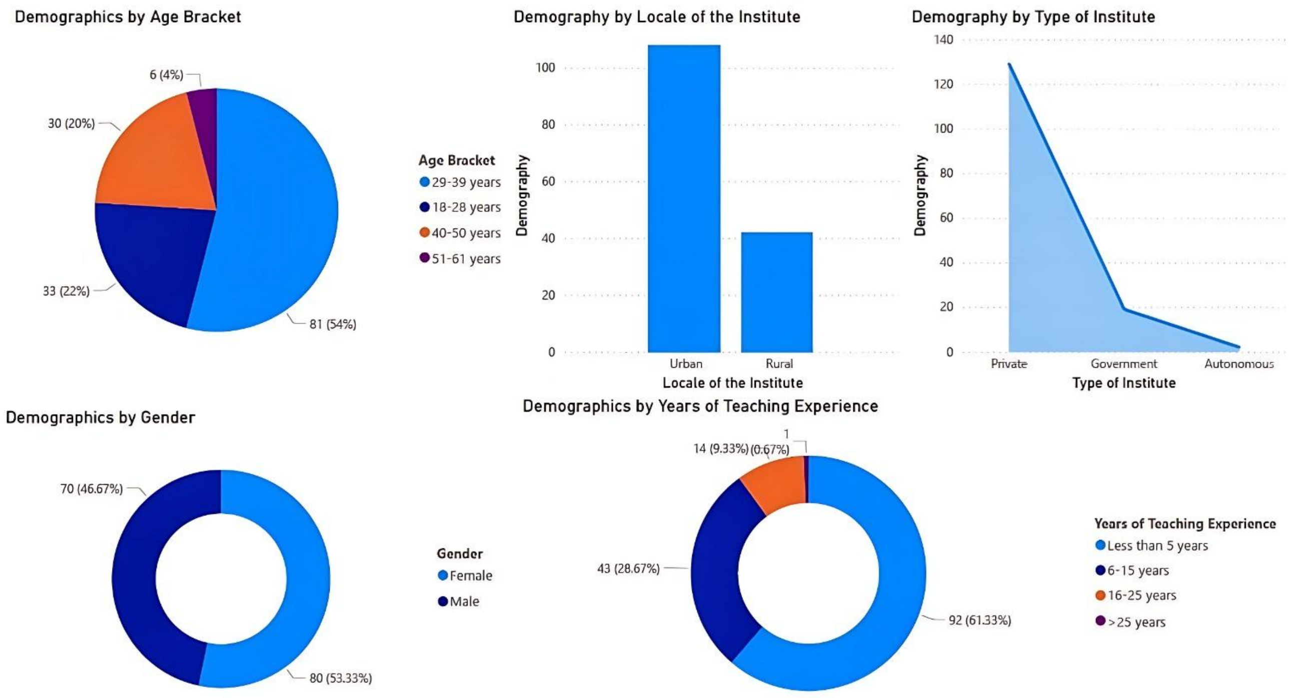

Figure 1. Demographic information of the respondents.

was general to technology, while 16 items related to VR, in particular, were preserved as the investigators desired to measure perception towards VR per se. The items were chosen based on expert opinion for strong content validity. A six-point Likert-scale was utilised: 1 – Strongly Disagree to 6 – Strongly Agree, and items in Italics were reverse coded as found in Table 1. The questionnaire for this study was generated using Google Forms and disseminated by email and text messaging. Teachers were informed that their involvement in the survey was voluntary, with the option to withdraw or finish later.

Table 1. Educators' perceptions of the use of VR in the classroom scale by Khukalenko et al. (2022)

S.No	Statements: Using VR in the classroom…..
1.	Improves student academic record
2.	*Does not make classroom management more difficult.*
3.	Promotes the development of communication skills (e.g., writing skills, presentation skills)
4.	*Is not too costly in terms of resources, time and effort*
5.	Is successful only if there's adequate teacher training in the use of VR technology in classroom
6.	Is successful only if equipment is regularly maintained by IT personnel.
7.	Is an effective tool for students of all abilities
8.	Effective if teachers participate in selection and implementation of VR technology
9.	Allows to accommodate individual attributes of students
10.	Motivates students to get more involved in learning activities.
11.	*Requires software training that is not too time consuming*
12.	Promotes the development of student interpersonal skills.
13.	Effective only if extensive technical resources are available
14.	*Requires no extra time to plan learning activities*
15.	Improves student learning of critical concepts and ideas
16.	*Is reasonable, thanks to the existence of subject specific software*

Data analysis

All the obtained responses were uploaded to IBP SPSS and AMOS for data analysis. To conduct confirmatory factor analysis (CFA), Kaiser-Meyer-Olkin (KMO) Test and Bartlett's Test of Sphericity (BTS) were performed to assess the sample size. According to Kline (2023) and Joseph et al. (2012), CFA is used to evaluate current theories or models and to validate the factor structure of observed data. Here, the scale was developed based on expectancy-value theory and is fairly new (i.e., 2006). As a strong theory base is available during the development of the scale, CFA was performed along with all indices, and the finalized scale's reliability quotient was obtained.

Results and Discussion

At the get-go, the investigators assessed the reliability quotient of the 16-item scale among the 150 respondents before further analysis. Cronbach's alpha was used to calculate reliability, with values over 0.70 indicating high reliability (Hair et al., 2010). The Cronbach's alpha retrieved was 0.792, which is lower than the reliability quotient retrieved when validated in the Russian context by Khukalenko et al. (2022) (Table 2). This further emphasizes the absolute need to validate the scale among Indian educators since perceptions of Virtual Reality are evidently different among Russian and Indian educators. This might be due to numerous factors, such as exposure to technology, training differences and availability, to name a few. Likewise, Russia is highly urbanized and has a higher Human Development Index when compared to India (Human Development Report, 2020).

Table 2. Reliability statistics of the adapted version of scale with 16-items when assessed in Indian. context

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.768	.792	16

Sampling size adequacy calculation

Before performing CFA, KMO and BTS were conducted to guarantee that the sample size was enough. The retrieved KMO value of 0.766 is significantly higher than the intended threshold and close to 1.0, which is highly welcoming. BTS values achieved 757.520, with a p-value of 0.000. This p-value is significantly less than the standard of <0.05 (Table 3). Therefore, both the sampling size adequacy tests indicate that the needed sample size to perform CFA on this scale was met.

Table 3. KMO and Bartlett's Test of Sphericity

Kaiser-Meyer-Olkin- 0.766		
Bartlett's Test of Sphericity	Approx. Chi-Square	757.520
	df	120
	Sig.	.000

Confirmatory Factor Analysis (CFA)

CFA is an effective statistical approach for delivering valid information (Hunter, 1982). It is utilised when numerous items are applied to measure a construct, the items have a direct association with the tool's average or total, and the researcher/s knows which items measure which structures beforehand. It involves comparing data to a suggested measurement model, assessing goodness of fit indices (GFIs), and determining validity based on acceptable fit retrieved. In this study, the 16 items are highly correlated with the construct under validation here, which is educators' perception of VR in the classroom.

The initial CFA model was run with the 150 university educators and Factor loadings retrieved for each of the 16 items showcase the association between each item and the factor (Discovering Statistics Using IBM SPSS Statistics - Andy Field - Google Books, 2009). The value describes how each variable contributes to the definition of a factor, otherwise known as dimension. Higher factor loading indicates a better representation of the factor. According to Hair et al., a value of more than 0.50 is considered practically significant (Hair, 2019). We noticed that the factor loading values of a few items fell below the cross-loading standard value of 0.5. The goodness of fit estimates was thereby poor and led to the deletion of the following 8 items: Item 2 (-0.14), Item 4 (0.27), Item 5 (0.29), Item 6 (0.45), Item 11(0.05), Item 13 (0.21), Item 14 (0.28) and Item 16 (0.03). Hence, the second model fit estimate was again carried out after removing the eight items, which resulted in satisfactory loading values ranging from 0.54 to 0.70 (Figure 2).

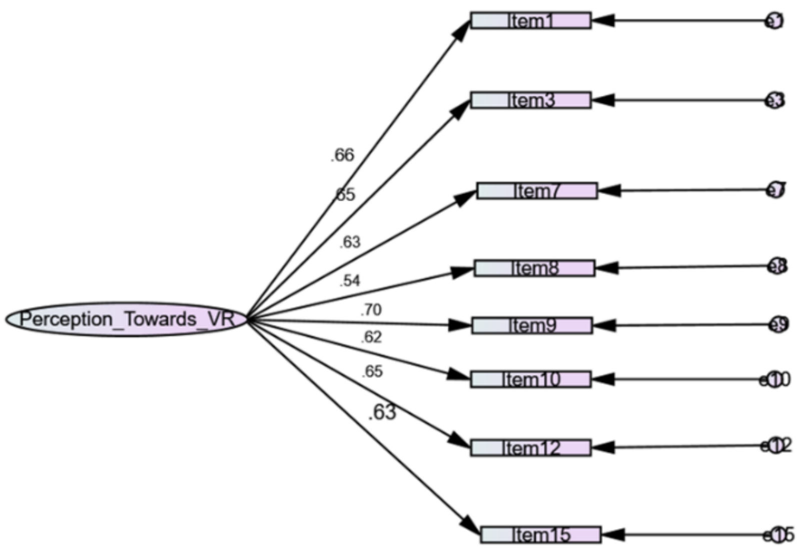

Figure 2. The Factor structure of the Model with eight items.

Overall Model fit summary

Cortes et al. (2019) proposed a few goodness-of-fit indices (GFIs) to assess the overall fit of a proposed model. Table 5 displays Model fit indices yielded with good results. This comprises of the p-value 0.000, which denotes a significant value (<0.05); CMIN/DF is 2.564 and is indicative of a satisfactory fit between the hypothetical model and the sample of the survey here; RMR (Root Mean Square Residual) shows 0.052 (<0.08) and also falls into the acceptable model fit. The GFI (Goodness of Fit index) value is 0.925 (>0.9). The IFI is 0.916 (>0.90) and lastly the CFI obtained is 0.914 (>0.95), which stands borderline below the acceptable value. This model fit indices show that the scale accurately measures educators' perceptions about

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employing VR in the classroom. Finally, the unidimensional eight-item correlated CFA model (Table 4) was found to hold good fitness indices and thereby fulfilled the cut-off values.

Table 4. The Fitness Estimates of the Model

Measures	P value	CMIN/ DF	RMR	GFI	AGFI	IFI	CFI
Result	0.000	2.564	0.052	0.925	0.865	0.916	0.914
Benchmark	<0.05	<3	<0.08	>0.90	0 -1	>0.90	>0.95

Reliability Analysis

A scale must not only be legitimate but also reliable. Brown (2015) defines reliability as the consistency of measuring outcomes. According to Roberts and Priest, 2009, a reliable tool ensures consistent measurement findings within a specific range. According to Margono (2015), a dependable instrument is one that can measure the same occurrence again and produce consistent findings. Thus, the reliability coefficient measures consistency. The scale with the final 8-items yielded a commendable reliability score of 0.843, which is almost near to the maximum of 1.00. We also notice that this value is higher than the reliability score yielded initially when the 16- items scale was assessed among the same Indian respondents (Table 2). This goes on to say that the new scale with eight items is more consistent and reliable for measuring this construct in the Indian context than the adapted version by (Khukalenko et al., 2022).

Table 5. Reliability statistics of the finalized version with eight-items

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.838	.843	**8**

Discussion and Conclusion

The aim of the study was to validate the adapted version of educators' perceptions of VR integration on a classroom scale in the Indian context. With ample evidence supporting the numerous gains of using VR in education, teachers' perceptions of such educational technology decide whether they are accepted or rejected, and if accepted, how successfully they are integrated into teaching. However, there is a dearth in the literature in terms of the availability of a suitable measurement tool to gauge their perception, specifically in the Indian setting. By using a sample of 150 Indian university educators, the study aimed to validate the scale adopted by Khukalenko et al. (2022) from Wozney et al. (2006). By following the stringent steps of CFA, the finalised scale retained eight items with a reliability quotient of 0.843. This scale can be utilised in a time-bound and reliable manner to gauge the educator's perception of using VR in education. As surveys on educators' perception of VR technology per se still remain in the infancy stage, which may also be due to the fact of a dearth in reliable tools to measure it, this validated version can be incorporated into a wide range of surveys and further assess the factors that determine the sprouting of such perceptions as well. The yielded responses can form pedagogically sound guidelines for integrating VR in the classroom, including professional development and teacher training. The investigators recommend the updated version to be validated further among early childhood educators, pre-service and in-service educators in order to further generalise its validity and reliability. Also, one of the limitations of the study was a small sample size (though statistically acceptable), which can be further backed up through a validation process undertaken on a larger sample size. However, the study included educators from different hierarchies of designation and across various states in the country, making it more reliable and generalizable.

Educational Implications

Targeted professional development workshops can be undertaken by using the scale and identifying the gaps that educators possess regarding the knowledge of utilising VR. Further, curriculum integration of VR can be mandated, focussing on the subjects and topics where teachers see the most potential. Infrastructure planning for allocating VR equipment and technical support for its integration can be carried out from the school side. Finally, policy frameworks that support and regulate the use of VR in education can be rolled out.

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Conflict of Interest

The authors declare that there is no conflict of interest

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