IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

ONLINE LEARNING ENVIRONMENT ENHANCE THE HIGH SCHOOL STUDENTS LEARNING SCIENCE THROUGH VIRTUAL REALITY

Author

Mrs. N. Prema,

Research scholar,

Vels Institute of Science, Technology and Advanced Studies,

Pallavaram, Chennai, Tamilnadu.

Co-Author

Dr. R. Meenakshi,

Professor in Education,

Vels Institute of Science, Technology and Advanced Studies,

Pallavaram, Chennai.

Corresponding Author

Dr. K. Sheeba,

Associate Professor in Education,

Vels Institute of Science, Technology and Advanced Studies,

Pallavaram, Chennai.

Abstract

STEM education, encompassing disciplines such as science, technology, engineering, and mathematics, serves as a cornerstone for cultivating critical thinking, problem-solving, and innovation skills essential for navigating the complexities of the modern world. Virtual reality (VR) technology offers a transformative approach to STEM education by providing immersive, interactive, and experiential learning environments. To analyse the VR in Science education approximately eighty students in the ninth grade from the Chennai area in the state of Tamil Nadu were chosen for the present study from the government school. There were forty students chosen from each of the groups in both control and experimental group. The result revealed that adopting the method of learning through VR has enhanced

the science learning with more interest and thus they experience better in learning science among the students by utilising the online learning environment.

Keywords: STEM education, Virtual Reality, Online Learning Environment.

INTRODUCTION

Traditional educational methods include teaching students through giving lectures in which students just listen to it. Regarding this mode of instruction, there is no participation from the students. The only purpose of textbooks is to read the chapters and commit them to memory; there is no room for creativity in this process. These techniques have been utilized for a wide range of years. In this type of approach, students are just passive listeners as there is no interaction with the objects. The possibility that Virtual Reality (VR) may be a useful technology to apply in education has generated interest in the design and development of VR applications for schools.

Virtual reality (VR) offers a number of benefits that distinguish it from other computer technologies that are currently being utilized in educational institutions. The ability to visualize and manipulate objects that cannot normally be seen in the real world; the capability of taking on different perspectives; the facility for exploring dangerous situations and providing a medium for presenting complex three-dimensional concepts (Crosier and Wilson, 1998). These are some of the capabilities that are included in the list. Therefore, virtual reality technology is an immersive and interactive technology that replicates a computer-generated environment. This technology gives users the ability to experience a sensation of presence and interact with virtual items and surroundings. A head-mounted display that follows the user's motions and gives the impression that they are physically present in a virtual world is often required for this type of computer-based experience.

STEM education, encompassing disciplines such as science, technology, engineering, and mathematics, serves as a cornerstone for cultivating critical thinking, problem-solving, and innovation skills essential for navigating the complexities of the modern world. Virtual reality (VR) technology offers a transformative approach to STEM education by providing immersive, interactive, and experiential learning environments. Virtual reality (VR) allows students to explore abstract topics through realistic simulations, interactive experiments, and virtual laboratories, in contrast to traditional teaching techniques, which mostly rely on lectures, textbooks, and graphics that are only two-dimensional. VR has the ability to bridge the gap between theoretical knowledge and real-world application in STEM courses by sending students to virtual worlds where they can control items, conduct experiments, and observe phenomena firsthand. This could be accomplished by transporting students to virtual-world environments.

Students are also provided with possibilities for experiential learning using virtual reality (VR). It is possible for students to perform chemical practicals in a real science lab, which can be hazardous for them. However, the same thing can be done in virtual reality labs, which can provide a safe and secure setting for students to carry out practicals.

Pedagogical strategies particularly well-suited to virtual reality include:

- **Gamification**: utilizing game-like elements like challenges, prizes, and competitiveness to make learning more enjoyable and inspiring.
- **Cooperative learning**: completing assignments or resolving issues in pairs or groups. It fosters idea sharing, collaborative skills development, and mutual learning and support among students.
- **Inquiry-based learning**: inspiring children to delve further into subjects by themselves, by asking questions and doing investigations. The focus here is on encouraging pupils to think for themselves rather than rote memorization of facts.

REVIEW OF RELATED LITERATURE

Virtual Reality Laboratories (VRLs) are a crucial step in the direction of educational solutions that would enable students to understand the occasionally intricate experimental procedures without the need for tangible resources. The setting in which an experiment would be done would be greatly impacted by the resources employed in particular experiments, which frequently involve substantial procurement effort. The primary goal of the study by Mila Dodevskaa et al. (2025) is to examine the potential of VR solutions as teaching aids and creative methods of producing scientific knowledge. The study covers a number of current virtual lab solutions while methodically reviewing pertinent literature in this field. The analysis demonstrates that VRL tools can be used to achieve the intended learning results, provide access to lab resources for individuals with impairments, and be used successfully for educational reasons. There is a difference between VRLs and real laboratories, particularly when it comes to the cooperative nature of the lab exercises. Nonetheless, there is a lot of research being done on this subject, and there is a lot of room for improvement.

According to PRISMA principles, Sharmiladevi Nagendran and Hafiz Zaini (2025) conducted a systematic review that examined the effects of different educational platforms on student motivation. The study examined 20 research papers on the use of virtual reality (VR) technology in education that were published between 2020 and 2024. The provision of realistic simulations that improve visual learning and concept retention is one of the major advantages of virtual reality, according to key results. Additionally, VR encourages experiential learning, which supports the growth of critical 21st-century competencies like problem-solving and practical skills. Although virtual reality (VR) has the potential to greatly increase student interest and engagement, the study also recognized the difficulties in integrating VR technology in learning environments. For teachers looking to successfully incorporate VR into their lesson plans and consequently enhance student learning results, this review is an invaluable resource.

Virtual reality (VR) integration in education is becoming more widely acknowledged for its potential to improve immersive learning settings, particularly for at-risk pupils dealing with issues like limited infrastructure and insecurity in Sokoto State, Nigeria. Using Albert Bandura's Social Cognitive Theory (SCT) as a guide, Sanusi Sani Danmali, Samuel Adebisi Onansanya, Falade Ayotunde Atanda, and Ahmad Abdullahi (2024) used virtual reality to teach STEM subjects (Science, Technology, Engineering, and Mathematics) and investigated how it enhanced learning engagement, interest in laboratory practicals, and educational outcomes for at-risk students. A mixed-method approach combined a quantitative quasi-experimental design with qualitative observations. In comparison to conventional teaching techniques, the study evaluated the effects of VR-based learning on at-risk students. A control group (n = 34) received traditional training, whereas an experimental group (n = 31) received VR-based instruction from a selection of 65 students. T-tests, descriptive statistics, and pre-test/post-test comparisons were used in data analysis.

The findings showed that VR-based instruction greatly increased students' interest in practical skills, learning results, and engagement. In addition to achieving higher post-test results in challenging areas like human anatomy and trigonometry, the experimental group demonstrated increased participation, on-task behavior, and contentment. According to the study's findings, virtual reality (VR) technology significantly improves STEM education for at-risk secondary school students, as evidenced by scores rising from 3.5 to 4.6, a mean gain of 33.4 points in performance, and an increase in interest in the hands-on laboratory practicals from 3.5 to 4.6. Virtual reality technology should be incorporated into secondary education curricula, according to the report. The translation of immersive experiences into academic success should be the subject of future research, with a focus on teacher preparation and assistance.

One of the most popular technology-supported learning settings is virtual reality (VR) applications, which make it easier and more permanent for students to learn topics. Since virtual reality (VR) is still relatively new and not widely used in classrooms, it is vital to look into how VR can be used in science classes and how students feel about these practices. The primary objectives of the study conducted by Urhan and Akpinar (2024) were to create the Virtual Reality Solar System Model (VRSSM) for the sixth-grade students' "Sun System and Eclipses" unit and to ascertain the students' opinions regarding the use of virtual reality applications in science classes. 16 students utilized the VRSSM to engage in this qualitative study. Data was gathered using a semi-structured interview form. Descriptive analysis and content analysis were used to examine the data. According to the study's findings, students want virtual reality (VR) to be used in scientific classes as well as other subjects. They also believe that VR can improve their science performance and that the knowledge they have acquired is permanent. Students also believe that the application improves their learning and piques their interest in science classes. Thus, it is anticipated that the findings of this study would result in the development and application of three-dimensional virtual reality learning environments pertaining to different science subjects and teaching levels.

Virtual reality (VR) has become more and more popular in recent years to support science teaching. The researchers' findings of how VR affects students' learning outcomes vary. The goal of Dhanil and Mufit's (2024) study is to use meta-analysis to map the findings of studies utilizing VR on student scientific learning outcomes. Studies on the effects of years of publishing, educational attainment, learning subjects, continents, immersion levels, and VR usage duration were also examined. Twenty-four works published in international journals between 2014 and 2023 merit analysis. The findings of the data analysis were displayed in size effect values, forest plots, and published bias tests using Excel and JASP programs. According to the investigation, VR scientific instruction outperformed traditional instruction in terms of learning outcomes. The degree of education and the duration of VR use did not significantly affect the moderator factors. However, the continent, the year of publishing, and the degree of immersion all had a big impact on schooling. These results demonstrate that VR is an effective technology that enhances students' learning outcomes in science. Other researchers can look into VR in relation to the teacher's position as a tutor or instructor, VR pedagogical approaches, VR device kinds, and students' technological proficiency with virtual reality.
The potential of virtual reality (VR) for teaching science in secondary schools has been studied at the University of Nottingham. The evaluation of VR to teach radioactivity at the secondary school level is described in the study by Joanna, Crosier, Sue Cobb, and John Wilson (2000).

The evaluation was conducted in a nearby school and directly contrasted with the conventional ways of teaching radioactivity that are already employed there. To enable comparisons, computer experience, computer attitudes, general attitudes, and information acquired were measured. Individual variations in home computer use, gender, and skill were also examined in connection to the aforementioned metrics. The order in which the requirements were performed and skill level both had a substantial impact on the attitude scores, according to the results. Both generally and specifically for the VR class, high ability students reported higher attitude scores. The Virtual Laboratory underwent significant modifications as a result of the evaluation research, and more evaluation studies were subsequently conducted.

NEED AND IMPORTANCE

Virtual reality thoroughly immerses students and entirely engages their senses in the subject matter. When students engage with ideas as though they are real, their brains build precise, detailed mental representations, enhancing knowledge retention by as much as 75%. Leveraging the advantages of virtual reality for information retention, educators can facilitate enhanced engagement for all students with abstract subjects through a more immersive experience.

Student achievement continues to pose a considerable issue in education, since numerous students struggle to engage completely with lessons or comprehend intricate concepts via conventional teaching approaches. The advantages of virtual reality demonstrate how immersive educational experiences can beneficially assist students. Virtual reality in education facilitates dynamic and memorable courses, enabling learners to comprehend content more profoundly and enhancing various student outcomes through experiential learning.
Virtual reality enhances cooperation and social competencies by fostering engaging, collaborative learning settings. Students can securely engage and explore learning subjects electronically in pairs or groups within the educational metaverse, thereby augmenting engagement and collaboration in the classroom. Utilizing the set of eight headsets for collaborative tasks enables educators to oversee student activities in real time, regulate behavior, and facilitate the seamless execution of tasks. The teacher's oversight enhances the collaborative essence of virtual reality in education, maintaining student engagement and facilitating effective group learning.

Participants in the VR condition demonstrated superior performance in 'remembering' compared to those in the traditional and video conditions. Self-assessments of emotions prior to and following the learning phase indicated an elevation in positive emotions and a reduction in negative emotions within the VR condition. Technology enables educators to provide individualized attention to each student using resources such as online learning modules, personal tablets, and, increasingly, virtual and augmented reality. Experts have discovered that virtual environments can provide kids needing additional support with opportunity to develop the skills necessary for achieving success in the classroom comparable to their classmates.

Students utilizing virtual reality have demonstrated significant advancements in various domains:

- Fourfold increase in concentration during lessons

- 275% increased confidence in the application of knowledge

- Fourfold increase in knowledge retention relative to conventional techniques.

The data illustrates the distinct advantages of virtual reality in education, offering compelling proof that immersive VR experiences can markedly improve engagement, understanding, and retention.

METHODOLOGY

A quasi-experimental design methodology is employed for the study. Assessments were performed on both the control group and the experimental group. Approximately eighty ninth-grade pupils from a government school in the Chennai region of Tamil Nadu were selected for the current study. Forty students were selected from each group in both the control and experimental categories. The pre-test and post-test were administered to both groups, and the data were analyzed using SPSS. The class was conducted using virtual reality techniques in an online learning environment within the realm of science. Both the control group and the experimental group were mandated to complete distinct pre-tests and post-tests. The examination score was calculated using SPSS analysis.

RESEARCH QUESTIONS

1. Is there is any significant difference among the Pre Test, Post Test and Gain Score for the Experience in virtual reality in both Control and Experimental group with Online Learning Environment?
2. Is there is any significant difference among the Pre-test, Post Test and Gain Score for the in usage of Internet in VR both Control and Experimental group with Online Learning Environment?
3. Is there is any significant difference among the Pre-test, Post Test and Gain Score for the Type of teaching method in both Control and Experimental group with Online Learning Environment?

FINDINGS AND DISCUSSIONTO THE RESEARCH QUESTIONS

Answer -Question No:1

Significance of mean difference among the Pre Test, Post Test and Gain Score for the Experience in virtual reality in both Control and Experimental group with Online Learning Environment

(N- Experimental group – 40; Control group – 40)

Test	Group	Experience in virtual reality	Mean	Standard Deviation	F ‘ Value’	Level of significance
Pre Test	**Control Group**	**Yes**	88.73	9.144	0.079	0.971 P>0.005 NS
		No	87.45	9.410		
	Experimental Group	**Yes**	88.19	8.280		
		No	87.63	5.852		
Post Test	**Control Group**	**Yes**	90.00	9.497	15.332	**0.000** **P<0.001** **S**
		No	88.48	9.594		
	Experimental Group	**Yes**	104.62	12.172		
		No	102.74	7.109		
Gain Score	**Control Group**	**Yes**	1.27	1.009	53.523	**0.000** **P<0.001** **S**
		No	1.03	.731		
	Experimental Group	**Yes**	16.43	8.942		
		No	15.11	4.886		

It is observed from the above table that in both control and experimental group students do not differ in their pre-test with respect to experience in virtual reality. Further it is found that experimental group students have more experience in virtual reality learning than the control group students, which is significant at 1% level. This proves that students have good experience in virtual reality with the help of online learning environment. In the gain score it is evident that the intervention given for the experimental group students in virtual reality with the online learning environment is effective when it compared with their counter parts.

Answer -Question No:2

Significance of mean difference among the Pre Test, Post Test and Gain Score for the in usage of Internet in VR both Control and Experimental group with Online Learning Environment

(N- Experimental group – 40; Control group – 40)

Test	Group	Internet in VR	Mean	Standard Deviation	F ' Value'	Level of significance
Pre Test	**Control Group**	Interested	83.37	6.536	0.734	P>0.005 NS
		Somewhat interested	81.25	10.079		
		Not interested	79.00	8.438		
	Experimental Group	Interested	71.64	7.455		
		Somewhat interested	85.25	6.251		
		Not interested	81.70	6.634		
Post Test	**Control Group**	Interested	79.47	8.885	4.482	**P<0.001 S**
		Somewhat interested	77.25	7.544		
		Not interested	77.33	8.383		
	Experimental Group	Interested	84.86	10.181		
		Somewhat interested	83.13	12.506		
		Not interested	84.70	8.206		
Gain Score	**Control Group**	Interested	3.90	7.915	3.682	**P>0.005 S**
		Somewhat interested	4.00	11.343		
		Not interested	1.67	7.146		
	Experimental Group	Interested	13.22	11.381		
		Somewhat interested	2.13	11.025		
		Not interested	3.00	12.649		

The aforementioned table indicates that both the control and experimental groups exhibit equivalent pre-test results regarding their interest in utilizing the internet for virtual reality. The experimental group students exhibit a greater interest in utilizing the internet for virtual reality learning compared to the control group students, with significance at the 1% level. This demonstrates that students exhibit a greater interest in utilizing the internet for virtual reality education. The gain score indicates that the intervention

provided to the experimental group of students, who are interested in utilizing the internet for virtual reality learning, is beneficial when compared to their counterparts.

Answer -Question No:3

Significance of mean difference among the Pre Test, Post Test and Gain Score for the Type of teaching method in both Control and Experimental group with Online Learning Environment

(N- Experimental group – 40; Control group – 40)

Test	Group	Type of teaching method	Mean	Standard Deviation	F ' Value'	Level of significance
Pre Test	**Control Group**	**Traditional**	89.29	8.866	1.276	P>0.005 NS
		Interactive	84.47	8.254		
		Technology - Enhanced	92.50	12.923		
	Experimental Group	**Traditional**	89.63	6.742		
		Interactive	85.20	9.414		
		Technology - Enhanced	87.93	5.484		
Post Test	**Control Group**	**Traditional**	90.52	8.992	9.958	**P<0.001 S**
		Interactive	85.33	8.566		
		Technology - Enhanced	93.75	13.074		
	Experimental Group	**Traditional**	103.56	10.328		
		Interactive	104.60	11.616		
		Technology - Enhanced	103.29	9.127		
Gain Score	**Control Group**	**Traditional**	1.24	.831	35.458	**P<0.001 S**
		Interactive	.87	.743		
		Technology - Enhanced	1.25	.957		
	Experimental Group	**Traditional**	13.94	6.981		
		Interactive	19.40	8.154		
		Technology - Enhanced	15.36	6.380		

The aforementioned table indicates that there is no significant difference in pre-test scores between the control and experimental groups for the teaching methods employed, namely traditional, interactive, and technology-enhanced virtual reality. The experimental group students exhibit a superior learning experience in technology-enhanced virtual reality compared to the interactive and traditional methods utilized by the control group, with significance at the 1% level. This demonstrates that students utilizing

technology-enhanced learning through interactive components in virtual reality have superior educational outcomes compared to traditional methods. The gain score indicates that the intervention provided to the experimental group, utilizing technology-enhanced virtual reality learning, is beneficial when compared to their counterparts.

CONCLUSION

It is conceivable to use virtual reality in education to develop immersive and interactive learning experiences that will transform students' understanding of science. VR technology has enormous potential in the field of science education. VR is becoming into a potent tool for individualized learning as this technology advances. VR simulations that adjust to each learner's pace and learning style make it easier for students to understand complex ideas. The integration process must be approached with meticulous preparation, continuous assessment, and an emphasis on matching VR experiences to curricular objectives and student requirements. By offering immersive and engaging learning experiences that encourage students to explore difficult scientific subjects through simulated online learning settings, virtual reality technology offers significant advantages.

REFERENCE

1. Dhanil, M., Mufit, F. (2024). How Virtual Reality Impacts Science Learning? A Meta-Analysis. International Journal of Interactive Mobile Technologies (iJIM), 18(22), pp. 77–96. https://doi.org/10.3991/ijim.v18i22.49989.
2. Geng, P. &Shen, D. (2024). Navigating the Future of Metaverse Education: A Comparative Study of VR and Non-VR Learning Environments. In M. Shelley & O. T. Ozturk (Eds.), Proceedings of ICRES 2024-- International Conference on Research in Education and Science (pp. 850-862), Antalya, Turkiye. ISTES.
3. Joanna K. Crosier, Sue V. G. Cobb and John R. Wilson (2000). Experimental Comparison of Virtual Reality with Traditional Teaching Methods for Teaching Radioactivity. Education and Information Technologies 5:4 (2000): 329±343.
4. Mila Dodevskaa, EftimZdravevskia, Ivan Chorbeva, Magdalena Kostoskaa, FredericoBrancob,c, Paulo Jorge Coelhod,e, Ivan Miguel Piresf,, PetreLameskia, (2025). Review article Virtual reality as a learning tool: Evaluating the use and effectiveness of simulation laboratories in educational settings Social Sciences & Humanities Open 12 (2025) 101742/
5. Portuguez-Castro, M.; Santos Garduño, H.(2024). Beyond Traditional Classrooms: Comparing Virtual Reality Applications and Their Influence on Students' Motivation. Educ. Sci. 2024, 14, 963. https:// doi.org/10.3390/educsci1409096.
6. Puiu, S.; Udris ,tioiu, M.T. (2024). The Behavioral Intention to Use Virtual Reality in Schools: A Technology Acceptance Model. Behav. Sci. 2024, 14, 615. https://doi.org/ 10.3390/bs14070615.
7. SanusiSani Danmali, Samuel Adebisi Onansanya, FaladeAyotunde Atanda, Ahmad Abdullahi (2024). Application of Virtual Reality in STEM Education for Enhancing Immersive Learning and Performance of At-Risk Secondary School Students..International Journal Of Research And Innovation In Social Science (IJRISS) ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue IIIS
8. SharmiladeviNagendran, Hafiz Zaini 92025). Perception on the Use of Virtual Reality (VR) for Science Subjects in Primary School: A Systematic Literature Review. International Journal Of Research And Innovation In Social Science (IJRISS) ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume IX Issue IIIS January 2025 | Special Issue on Education
9. TommasoSantilli a a , Silvia Ceccacci a , Maura Mengoni b,* , CatiaGiaconi Department of Education, Cultural Heritage and Tourism, University of Macerata, Macerata (2025). Virtual vs. traditional learning in higher education: A systematic review of comparative studies, Italy b

Department of Industrial Engineering and Mathematical Science" (DIISM), Polytechnic University of Marche, Ancona, Italy.Computers & Education 227 (2025) 105214

10. Urhan,O., & Akpinar, E. (2024). The views of students regarding the use of virtual reality applications in elementary science classes. Science Insights Education Frontiers, 21(1):3329-3348.
11. Zhang,Y.;Luo,H.; Peng, S.; Han,X.(2025). Virtual Reality or Videoconferencing for Online Learning? Evidence from Comparative Meta-Analyses. Appl. Sci. 2025, 15, 6293. https://doi.org/10.3390/app15116293.