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Influence of Learning Style Differences on Students' Perceived Enjoyment and Usefulness of Virtual Reality Tools in Education

Dheeraj Yadav[1]
Saroj Yadav[2]
Anamika Yadav[3]

Abstract

The present study analyzed the differences between VARK learning style preferences of undergraduate students in terms of their perceptions of the usefulness and enjoyment of VR tools in education. An explanatory sequential mixed methods design was used to gather quantitative data from 215 undergraduate students with prior experience of using VR tools in an academic course, and qualitative data from 20 students across the four VARK categories: visual, auditory, reading/writing, and kinesthetic. Descriptive statistics, one-way analysis of variance (ANOVA) and Tukey HSD post-hoc tests were used for quantitative data analysis and thematic analysis was used for qualitative data analysis. The findings indicated that there were statistically significant differences between the groups in terms of perceived enjoyment and usefulness of VR tools. The kinesthetic learners reported the highest mean scores of enjoyments and perceived usefulness and the visual learners reported the next highest mean scores, while the auditory and reading/writing learners reported comparatively lower scores. The qualitative results also suggested that the immersive and interactive nature of VR created a higher sense of presence with kinesthetic and visual learners and some of the auditory and reading/writing learners were experiencing a gap between the VR presentation and their preferred learning approach. One limitation of the study is that VARK preferences were self-reported, and the data was obtained from a single university. The results indicate that the incorporation of VR in the education sector should be supported by multimodal learning resources as a means to have students of various learning preferences interact with the learning environment in an effective manner. The study provides empirical evidence on the relationship between students' learning preferences and their perceptions of the VR-based educational technology.

Keywords: *Learning Styles, Virtual Reality, Student Perception, ET, VARK Model*

[1]Research Scholar, Department of Education, University of Allahabad, Prayagraj (Uttar Pradesh)
[2]Associate Professor, Department of Education, University of Allahabad, Prayagraj (Uttar Pradesh)
[3]Assistant Professor, Department of Education, University of Allahabad, Prayagraj (Uttar Pradesh)

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1.0 Introduction

Digital technologies have rapidly evolved and shaped the design and delivery of teaching and learning in higher education. Of these technologies, virtual reality (VR) has received significant interest as it allows viewers to interact with a 3D computer-generated environment and to experience situations that would be hard, costly, unsafe or impractical to recreate in traditional classrooms. VR can enhance a learner's sense of presence, offer active learning opportunities, and create a sense of immediate engagement with learning content, through head-mounted displays and interactive virtual environments. The capabilities of VR make it relevant to experiential learning approaches and constructivist approaches to learning, where learning is achieved by engaging in meaningful experiences (Kolb, 1984; Radianti et al., 2020).

There is an increasing amount of empirical evidence to support the educational value of VR. In a meta-analysis on virtual-reality based instruction in K–12 and higher education, Merchant et al. (2014) found the overall effect of VR-based instruction on learning outcomes to be positive. Jensen and Konradsen (2018) summarized the applications of HMDs in education and training and found that immersive VR could be useful in several educational settings in the training of skills and cognitive learning, but the effectiveness of VR is contingent on the instructional design and learning task. In a systematic review of immersive VR applications in higher education, Radianti et al. (2020) noted that VR was used in many disciplines including medicine, engineering, science, and social sciences, and highlighted the potential of VR for experiential, situated, and interactive learning. Likewise, a systematic review by Hamilton et al. (2021) of 29 experimental studies found many studies showed benefits of immersive VR compared to less immersive methods of instruction, but also significant differences in study design and measurement.

Allcoat and von Mühlenen (2018) determined that students who received their instruction in VR perceived more positive emotional experiences and were more engaged than students who did not receive their instruction via VR or traditional methods. In a study with 104 university students, Makransky and Lilleholt (2018) found that immersive VR had especially high levels of presence and motivation versus desktop VR. Another study, by Parong and Mayer (2018), showed that college students exposed to immersive VR were more interested, more motivated, and more engaged than were students exposed to a traditional slideshow. The results show that the factors of enjoyment, engagement, motivation, and

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perceived value are important components in determining students' reactions to VR. In parallel, empirical evidence shows that deeper immersion is not a guarantee of improvement in learning for all learners, or in all learning contexts. Parong and Mayer (2018) found that although immersive VR increased students' interest and motivation, students using a well-designed slideshow obtained higher post-test scores in one experiment. University students also had a greater sense of presence in immersive VR, with higher cognitive load and lower learning performance compared to students in a desktop version of the same science simulation, as reported by Makransky et al. (2019). In an immersive VR study with 77 students, Huang et al. (2020) show that there was no direct link between learning-style preferences and learning achievement, but a difference in subjective presence and cognitive load. This type of results shows that VR's effectiveness and experience can be different for different learners and for how they interact with the technological environment.

This variation offers a significant motivation for studying differences in learners. Students don't always think and act in the same way about the same educational technology. Prior experience, types of engagement, cognitive loads, motivation, and expectation can influence perceptions of enjoyment and usefulness of a VR setting. Fleming and Mills (1992) have identified four ways in which students most often prefer to learn: visual, auditory, reading/writing, and kinesthetic. The notion that instruction should be tailored specifically to a given “learning style” has been debated due to the insufficient supporting evidence (Pashler et al., 2008), however VARK can continue to be used with caution as a way of describing students' self-reported learning style preferences for interacting with information. For example, Leite et al. (2010) investigated the psychometric properties of VARK scores and cautioned against interpreting VARK learning-preferences.

In VR, the immersive nature of the environment makes it particularly important to take into account the learner's preferences. VR applications frequently involve the integration of visual displays, navigation through space, real or virtual manipulation, sound, textual input and interactive feedback. This means that for some students, the interactive and image-oriented nature of VR might be very engaging while for others, it might be more interesting to receive information through text or audio. Huang et al. (2020) concluded that different cognitive load and presence levels were observed in an immersive VR environment for students with different learning preferences. Shen et al. (2019) investigated VR acceptance with data from 376 university students and their learning style dimensions, revealing that

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learning style concrete-experience dimension positively influenced students' behavioural intention to use head-mounted display, and technology-acceptance factors had significant influence on VR users' behavioural intention to use HMD. The results indicate that a person's VR characteristics should be taken into account in the analysis of students' acceptance and subjective experiences of VR.

In this study, only perceived usefulness and perceived enjoyment are examined because these perceptions are significant factors for the acceptance and continued use of educational technology. According to the Technology Acceptance Model, perceived usefulness is an important factor that influences users' attitude and behavioural intention to use technology (Davis, 1989). Further technology-acceptance research has also shown that beliefs about the value and experience of technology affect users' decisions to adopt and persist in using it (Venkatesh et al., 2003). Enjoyment is also important in educational VR as it may be designed to offer an entertaining and interactive experience within the VR setting. The integration of VR into teaching might be undermined if students think VR is not useful, but fun, or fun but not useful. Hence, an analysis of both dimensions gives us a more holistic picture of the students' experience than an analysis of achievement.

The study is also justified from practical point of view. If an institution is thinking about implementing VR, they have to purchase the equipment and software, train teachers, invest in technical infrastructure, maintain it, and introduce VR into the educational environment. These investments should be directed by evidence that VR can enhance learning outcomes, as well as evidence regarding student experiences and perceptions of VR, across different student groups. Adopting a consistent method of implementing VR might be helpful for some learners, while potentially causing usability, cognitive or instructional challenges for others. Based on this, learner differences in VARK preferences in terms of enjoyment and perceived usefulness can be identified and might be of assistance for instructional designers and educators in creating flexible, multimodal, and inclusive VR learning environments.

As more and more publications have emerged on VR in education, there is still a significant research gap. Most of the existing research has focused on overall learning achievement, presence, motivation, engagement, cognitive load, or intention to use VR (Hamilton et al., 2021; Jensen & Konradsen, 2018; Makransky & Lilleholt, 2018; Makransky et al., 2019; Merchant et al., 2014; Parong & Mayer, 2018; Radianti et al., 2020). Relatively scarce empirical studies have directly focused on the differences in students' enjoyment of VR and

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their perceived educational value, as related to the various learning-preference categories. Huang et al. (2020) conducted a study on the relationship between learning preferences and presence, cognitive load and learning outcomes and Shen et al. (2019) conducted a study on learning dimensions and behavioural intention. Therefore, additional studies are needed to answer the question of if there are systematic differences in affective and usefulness perceptions reported by students classified by VARK preferences when using VR in education. To address the aforementioned gap, the present study looks at how undergraduate students perceived the educational VR to be enjoyed and useful for students with varying preference styles (visual, auditory, reading/writing, and kinesthetic).

1.1 Objectives of the Study

The study aimed at achieving the following objectives:

- To investigate how enjoyable undergraduate students from various VARK learning-preference groups find VR tools.
- To explore understanding of the usefulness of virtual reality tools among undergraduate students from various learning-preference groups.
- To find out if there is a significant difference in student perceptions of the enjoyment of virtual reality tools between the groups of students with visual, auditory, reading/writing and kinesthetic preferences.
- To see if there is a significant difference between the groups in terms of the perceived usefulness of the virtual reality tools (visual, auditory, reading/writing, and kinesthetic).
- To investigate student experiences with the characteristics of VR that facilitate their sense of enjoyment, usefulness and suitability to the way they interact with learning materials.

1.2 Hypothesis of the Study

H_1: There are statistically significant differences in students' enjoyment of VR tools across different learning styles.

H_2: There are statistically significant differences in students' perceived usefulness of VR tools across different learning styles.

2. Literature Review

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2.1 Literature related to Virtual Reality in Education

Virtual Reality (VR) has become a revolutionary technology in the education field, providing immersive, interactive, and engaging learning experiences that are impossible to achieve in the classroom. VR provides students with the opportunity to experience the real-world environment and scenarios, providing experiential learning opportunities and enabling students to put theory into practice (Radianti et al., 2020). This is consistent with Kolb's (1984) Experiential Learning Theory which highlights the need to engage in learning processes.

A number of empirical studies highlight the potential of VR to increase student engagement, motivation and retention. A systematic review by Jensen and Konradsen (2018) showed that VR can significantly enhance the cognitive learning outcomes of educational programs in different fields such as medical training, engineering and arts. VR's sensory-rich environments enable multi-modal learning, through the synthesis of visual, auditory, and kinesthetic inputs, which are commonly reported to be one of the reasons for increased student satisfaction (Bailenson, 2018).

In addition, VR technology has become increasingly common, and VR equipment, including head-mounted displays (HMDs), is becoming more accessible, making VR tools more viable in the mainstream education system. The technological transition is backed by efforts in higher education institutions around the world for innovation in pedagogical approach through the use of VR (Pottle, 2019).

2.2 Learning Styles

Learning styles are the ways in which a student learns that are different from others. The VARK model (Fleming & Mills, 1992) is one of the most commonly used models in educational psychology. It distinguishes between four types of learners:

- Visual Learners: Like to see diagrams, charts and visual aids.
- Auditory Learners: Learn best by listening.
- Reading/Writing Learners: Prefer written information and text input.
- Kinesthetic learners: These learn through doing and hands-on activities.

The simplicity and applicability of the Vark model have made it very popular in research and implementation, especially in teaching. Leite et al. (2010) found that accommodating learner's learning styles in instructional design can enhance their engagement and learning. But the model has also been criticized for the absence of empirical support for its predictions

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of academic performance, leaving the question of its universal applicability (Pashler et al., 2008) open for debate.

Although these criticisms have been raised, many teachers still rely on learning styles frameworks as tools to create a variety and inclusiveness of educational experiences.

2.3 Gaps in Current Research

Although numerous studies have examined the overall effectiveness of VR devices for enhancing educational outcomes, there are fewer studies that focus specifically on understanding the role of students' learning styles in affecting their experience and perception of learning in the VR environment. Merchant et al. (2014) performed a meta-analysis, which focuses on the general effectiveness of VR instruction, but failed to consider perception and engagement of individual learners.

While most studies have looked at learning outcomes in general, the subjective aspects of learning, including enjoyment and perceived usefulness are important and relevant to technology acceptance models (Venkatesh et al., 2003). Also, studies have tended to be narrow in scope, targeting specific programs such as health care training or STEM courses and not addressing other subjects.

The lack of knowledge creates obstacles for the education practitioners who wish to use VR well in a way that is useful for all pupils. Without an understanding of how various learning styles have an impact on perceptions of VR, there is potential for excluding some student groups or misallocating resources. Therefore, it is clear that empirical studies directly exploring these moderating variables are needed to inform more complex and comprehensive approaches to the integration of VR in education.

3. Methodology

3.1 Research Design

The research design used in this study was a mixed methods research design, which combines quantitative and qualitative approaches to explore the learning style effects on students' perception of enjoyment and usefulness of virtual reality (VR) tools in education. Both quantitative and qualitative data provided by the survey and the interviews enabled the analysis to be both broad and deep, giving a more complete picture of the research problem (Creswell & Plano Clark, 2018). The focus of the study was an explanatory sequential

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design; whereby quantitative results informed the design of qualitative interview questions that further explored patterns that emerged.

3.2 Population and Participants

The population of the study consisted of the students of undergraduate class at the selected large public university of India during the period of data collection. The research directly focused on VR in education, so the criteria for selecting the participants was limited to respondents who were undergraduate students and during the last 12 months had used a VR tool or VR-based learning environment in at least one academic course. Students under the age of 18 were not included since they did not have prior academic experience with VR, which would have been necessary to make experience-based judgments about the enjoyment and usefulness of VR for learning.

The accessible population included eligible undergraduate students who were able to be contacted by university emails, classroom announcement and social media notices that have been used for recruitment. Participation was voluntary. Those who participated in the invitation and met the eligibility criteria were included in the quantitative part of the study. Therefore, the participants were not the whole population of the undergraduate population, but merely students who had some educational experience with VR.

A total of 215 undergraduate students at a large public university in India were considered and analyzed in the study. The participants were identified through email sent to all students in the university, social media and classroom announcements. The inclusion criteria for participation included experience with VR tools in at least one academic course in the previous 12-month period.

In the qualitative phase, 20 students were randomly chosen from the quantitative participants, and subjected to semi-structured interviews. Each student is chosen for the study so that the four VARK learning-preference categories are represented. The aim of the qualitative phase was to find out more detailed explanations of the pattern revealed in the quantitative data. Based on the explanatory sequential mixed-methods design, the interviews were then used to help explain the data that emerged from the students in different learning-preference groups reporting different levels of enjoyment and perceived usefulness of VR (Creswell & Plano Clark, 2018).

3.2.1 Demographic Breakdown

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Table 1. Demographic profile of the quantitative sample (N = 215)

Variable	Category	Reported statistic
Gender	Female	58%
	Male	41%
	Non-binary/Other	1%
Age	Range	18-25 years
	Mean	20.7 years
Academic discipline	STEM	55%
	Humanities and Social Sciences	45%

Table 2. VARK learning-style preference classification

Preference group	n	%
Visual	51	23.7
Auditory	45	20.9
Reading/Writing	40	18.6
Kinesthetic	79	36.7
Total	215	100.0

3.3 Research Tools and Components

The use of three tools was involved. Participants' self-reported preferences were categorized in four categories (VARK Questionnaire – Version 8.01): visual, auditory, reading/writing, and kinesthetic. In the quantitative analysis, the grouping variable was the VARK result. As VARK is presented here as a preference measure, the categories are interpreted descriptively (Fleming & Mills, 1992; Leite et al., 2010).

Second, the VR Perception Scale was a 5-point Likert type with two factors of the study: Enjoyment and perceived usefulness. The higher the component scores, the more positive the perceptions were. Cronbach's alpha appeared to be .89 for the total scale and .87 for the enjoyment component and .85 for the perceived usefulness component. The component scores were examined separately from each other without being aggregated into an overall score.

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Third, the 20 students were interviewed using a semi-structured interview schedule. The interview probes included themes of immersion, presence, enjoyment, engagement, perceived usefulness in understanding, perceived usefulness in practice, barriers and mismatches between the way VR presents information and how students like to work with information. These domains were employed to describe the quantitative patterns and not to create more numerical scores.

Table 3. Research tools, components, and role in analysis

Tool	Components/domains	Role in analysis
VARK Questionnaire (Version 8.01)	Visual; Auditory; Reading/Writing; Kinesthetic	Grouping variable for quantitative comparisons
VR Perception Scale	Enjoyment; Perceived usefulness	Two separate 1-5 component scores; dependent variables in ANOVA
Semi-structured interview schedule	Presence/immersion; enjoyment/engagement; usefulness; barriers/preference fit	Thematic explanation of quantitative differences

3.4 Procedure

The data collection was done in two stages. VARK preference groups and the two scores for the VR Perception Scale were identified after students completed the quantitative measures during Phase 1. The quantitative results were examined to see if there were any group patterns. Phase 2 involved further semi-structured interviews with 20 respondents from each of the four preference groups. Interview questions centered on their experiences of enjoyment, usefulness and difficulty of specific aspects of VR including the use of three-dimensional visualization, interaction, pacing, verbal guidance and text support.

3.5 Data Analysis

Data were analyzed using SPSS version 26 in quantitative data analysis. Descriptive statistics for the sample were computed, as were descriptive statistics for each VR Perception Scale item. Two one-way analyses of variance (ANOVAs) were carried out using the independent variable VARK preference group; one for enjoyment and the other for perceived usefulness. The level of significance was set at .05. Since both omnibus ANOVAs were significant, Tukey HSD (Honestly Significant Difference) post-hoc comparisons were

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used to determine which group means were different. The sum of squares reported were used to compute eta-squared as the proportion of variance explained by the learning-style group. Braun and Clarke's (2006) six-phase thematic approach was used for qualitative analysis of the data: familiarization, initial coding, searching for themes, reviewing themes, defining and naming themes, and report production. Support of coding and organization were achieved through NVivo. Integration was done during interpretation, and the qualitative themes used to account for the direction of the quantitative group differences.

4. Data Analysis and Results

H_1: There are statistically significant differences in students' enjoyment of VR tools across different learning styles.

Table 4: Descriptive Statistics by Learning Style

Learning Style	N	Mean Enjoyment	Std. Deviation (Enjoyment)	Mean Usefulness	Std. Deviation (Usefulness)
Auditory	45	3.21	0.82	3.41	0.73
Kinesthetic	79	4.53	0.40	4.67	0.40
Reading/Writing	40	3.18	0.75	3.14	0.71
Visual	51	3.97	0.56	3.98	0.62

Interpretation

The patterns shown in the descriptive statistics table were distinct in relation to the perceptions of enjoyment and usefulness of the virtual reality (VR) tools in education among the different learning styles. Specifically:

The mean scores of the kinesthetic learning style for enjoyment (M = 4.53, SD = 0.40) and usefulness (M = 4.67, SD = 0.40) were the highest, indicating that they greatly enjoyed and found VR tools very useful in comparison to other learning styles.

The mean scores of visual learners were relatively high (Enjoyment: M = 3.97, Usefulness: M = 3.98).

The mean scores of the Auditory and Reading/Writing learners were lower, with the lowest mean score for usefulness (M = 3.14, SD = 0.71) being the Reading/Writing learners.

The description of these patterns provide support for the assumption that VR, as a multi-sensory and interactive medium, is more kinesthetic/visual learning friendly.

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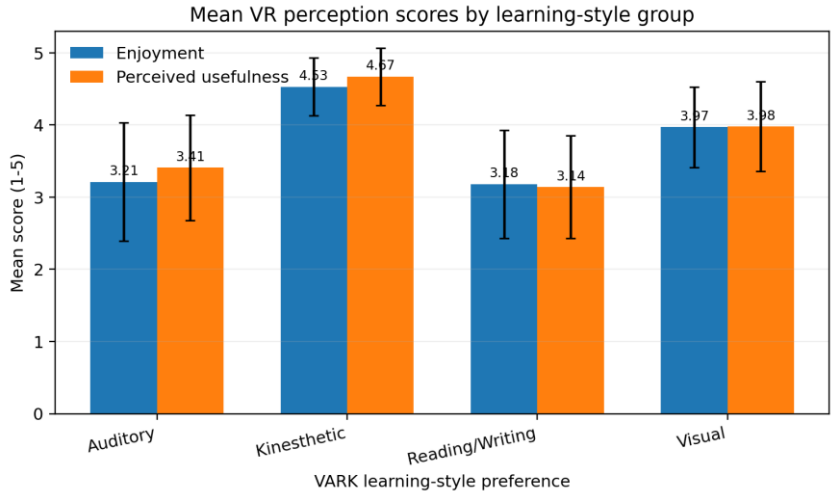


Figure 1. Mean enjoyment and perceived usefulness scores by VARK preference group. Error bars represent +/- 1 SD.

Table 5: ANOVA Results

Source	Sum of Squares	df	F	Sig. (p-value)
Learning Style	73.85	3	65.21	7.07×10^{-30}
Residual	79.65	211	—	—
Total	**153.50**	**214**		

Dependent Variable: Enjoyment

Interpretation

According to the ANOVA test, the difference between the learning style and the scores of enjoyments is very significant at $p < 0.001$. The large F value of 65.21 suggests that the difference between the scores of enjoyments was strongly related to the difference in learning styles, and not due to random variation within groups.

Practical Insight: Educational practitioners can anticipate the different levels of enjoyment that students may experience with VR tools, with kinesthetic learners potentially enjoying them most.

H_1 Accepted: Kinesthetic learners had the highest mean enjoyment score (M = 4.53, SD = 0.40), which was significantly higher than all the other groups.

Table 6: Tukey HSD Post-hoc Test Results for Enjoyment

Group 1	Group 2	Mean Difference	p-value	Significant?
Auditory	Kinesthetic	1.33	< 0.001	Yes
Auditory	Reading/Writing	-0.02	0.998	No

Auditory	Visual	0.76	< 0.001	Yes
Kinesthetic	Reading/Writing	-1.35	< 0.001	Yes
Kinesthetic	Visual	-0.56	< 0.001	Yes
Reading/Writing	Visual	0.79	< 0.001	Yes

Interpretation

The greatest mean difference was found between Kinesthetic and Reading/Writing learners (-1.35, $p < 0.001$) indicating a large difference in enjoyment perceptions.

There was no significant difference between Auditory and Reading/Writing learners ($p = 0.998$), meaning that there was no difference of enjoyment between these two styles.

The results of all other pairwise comparisons were statistically significant ($p < 0.001$), further confirming the different preference patterns found in the descriptive statistics.

Hypothesis 1 is accepted. Statistically significant differences in enjoyment score were found between most learning style groups with Kinesthetic showing the lowest scores and all other groups showing the highest scores.

Hypothesis 2 (H2): There are statistically significant differences in students' perceived usefulness of VR tools across different learning styles.

Table 7: ANOVA Result

Source	Sum of Squares	df	F	Sig. (p-value)
Learning Style	80.20	3	75.27	3.84×10^{-33}
Residual	74.94	211	—	—
Total	**155.14**	**214**		

Dependent Variable: Usefulness

Interpretation

The ANOVA result shows a statistically significant difference for perceived usefulness of VR tools among learning styles ($p < 0.001$) and the F value is very high (75.27). It is a confirmation of the fact that learning style is a good predictor of perceived usefulness.

Practical Insight: Conceiving the differences between learning styles and how they might affect the learning experience as acceptance and perceived educational value of VR in teaching education would be essential.

Table 8: Tukey HSD Post-hoc Test Results for Usefulness

Group 1	Group 2	Mean Difference	p-value	Significant?

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Auditory	Kinesthetic	1.26	< 0.001	Yes
Auditory	Reading/Writing	-0.26	0.180	No
Auditory	Visual	0.58	< 0.001	Yes
Kinesthetic	Reading/Writing	-1.53	< 0.001	Yes
Kinesthetic	Visual	-0.69	< 0.001	Yes
Reading/Writing	Visual	0.84	< 0.001	Yes

Interpretation:

Again, Kinesthetic learners showed significantly higher usefulness scores than all of the other groups.

The difference between Auditory and Reading/Writing learners was not statistically significant (p = 0.180), showing that there was no difference in the views of usefulness between the two styles.

Other comparisons were statistically significant, indicating the differences in the degree of usefulness of VR tools based on learning style.

Hypothesis 2 is accepted. There are differences between most of the learning style groups on scores of perceived usefulness, with statistical significance shown between the Kinesthetic learner group and the other groups, particularly the more positive scores of the Kinesthetic learner group.

Post-hoc comparisons

Again, post-hoc comparisons revealed scores were highest in the kinesthetic group. Among the three groups, the mean perceived usefulness of kinesthetic participants (M = 4.67) was significantly higher than that of the auditory participants (M = 3.41) and reading/writing participants (M = 3.14) (all p < .001), but not significantly different from that of the visual participants (M = 3.98). Additionally, visual participants reported significantly more useful than auditory and reading/writing participants, both p < .001. There was no significant difference between the two groups (auditory vs reading/writing) (p = .180). H2 was thus favoured.

4.2 Qualitative Insights

Analysis of the semi-structured interviews identified two themes as emerging from the qualitative findings and these help to further explain the quantitative findings:

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Theme 1: "Feeling of Presence"

Many of the VR users, especially those identified as kinesthetic and visual learners, highlighted the immersive nature of the VR environments as a key element that enhanced their enjoyment and usefulness. This is reflected in comments like 'I feel like I'm in the simulation' and 'Looking at the model in 3D helped me to understand much better than reading in a textbook.

VR experiences were especially favoured by kinaesthetic learners, who also found interactive features beneficial because they most closely matched their learning style. "VR is the closest thing to real-life practice without being in a lab" was the word of one of the kinaesthetic learners. Visual learners emphasized that to have a better understanding of concepts they need more detailed visual aids like- graphics and/or animation. The theme is quite relevant in the field of researches related to VR as it talks about experiential and constructivist learning.

Theme 2: "Mismatch with Learning Preference"

Reading/writing learners, on the other hand, showed need for print materials. It is because of overload of information around them and also problem in using VR technologies. As said by one of the students, "I just like to read at my own speed. I don't like it feeling all disorganized and too fast in VR."

While the main worry of auditory learners was the lack of organized verbal instructions in many VR technologies.

Through the results, it was found that for visual and kinesthetic mode learners, default configuration of VR technologies is more important in comparison to those students who learn best from reading or listening.

5. Discussion

The main aim of the research was to explore about the perception of students regarding VR in education which was done through mixed-method approach.

5.1 Summary of Key Findings

The key findings are provided with an interpretation.

The study revealed that there were significant differences between VARK preference groups in terms of educational VR's enjoyment and perceived usefulness. The means were highest for the kinesthetic participants, followed by the visual, then the auditory and reading/writing participants. The kinesthetic and visual groups were significantly different from the lower-

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scoring groups whereas there was no significant difference between the auditory and reading/writing groups. Tukey HSD tests revealed this. The qualitative themes were consistent with this, and were described as the presence of the stimulus, interaction, and three-dimensional visualization; or limited text support, pacing concerns, and insufficient structured verbal guidance.

The results corroborate earlier research which has demonstrated that VR can elicit significant motivational and experiential responses. Makransky et al. (2019) reported greater enjoyment and intrinsic motivation with immersive VR compared to laboratory-safety training using text-based instruction, and Parong and Mayer (2018) reported greater interest and engagement with immersive VR as compared to a slideshow condition. The present results continue this research and indicate that not all participants in the current sample perceived this positively. Additionally, they support previous studies by Shen et al. (2019) that showed a relationship between both technology-acceptance beliefs and an experiential learning-style dimension with students' intention to use VR.

Concurrently, the results are not to be viewed as evidence that instruction should be tailored to a student's VARK category. Self-reported preferences and subjective VR perceptions were measured, but not learning outcomes resulting from the modality matching. The literature on learning styles does not support the idea that students learn best when teaching is tailored to one learning style (Pashler et al., 2008) and there are concerns about the psychometric properties of VARK (Leite et al., 2010). The more defensible answer is that students might have different experiences of the affordances and constraints of the same VR environment.

5.2 Theoretical Implications

The results justify the use of learner level factors in conjunction with the constructs of the technology acceptance models in studies on educational VR. The TAM central construct, perceived usefulness varied significantly among preference groups, as did enjoyment. This indicates that an aggregate score does not necessarily reveal significant differences among students. Future developments of educational VR acceptance models should thus consider the factors of learner characteristics, prior VR experience, technology self-efficacy and instructional design features as moderators or antecedents in lieu of a uniform user response.

5.3 Practical Implications

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The results suggest that a multimodal VR design, and not only a learning style label, is suitable for educational practice. VR lessons can maintain the visual and interactive, with the option of captions, brief text summary, scripted narration, replay controls, prompting, and reflection elements. What this type of feature might do is eliminate the strengths reported by reading/writing and auditory participants and lower the pacing and information format barriers reported by kinesthetic participants. It is also recommended that orientation be conducted before the VR activity, to familiarize students with the navigation and interaction requirements so that, when the interaction and navigation demand appear during the VR activity, they can be separated from the learning task.

5.4 Limitations and Future Research

The results have to be interpreted with some caution due to a number of limitations. The research was carried out at one public university in India, and thus the findings might not be applicable to other universities, fields of study, or cultures. It was a voluntary participation study which meant that there was a risk of self-selection bias, and self-report was used as the basis for VARK classification. The level of prior knowledge of VR and related technologies was not controlled, but may affect enjoyment and perceived usefulness. Furthermore, the study was not about learning outcomes per se, but rather perceptions of learning, so the implications on the effectiveness of VR learning are not conclusive.

Future studies should involve multiple-institution samples, include a measure of prior VR experiences and technology SE, and test the extent to which the differences in perceptions noted in this study may generalize to various disciplines and types of VR applications. Evaluation of learning outcomes and perception in experimental studies may involve interventions to design supports, such as narration, captions, text summaries, pacing controls, and degree of interactivity, or their combination. The results of the longitudinal work would also answer the question of whether original perceptions of enjoyment and usefulness stay constant with repeated VR use.

6. Conclusion

This study examined the impact of students' learning styles on their levels of enjoyment and perceived usefulness of virtual reality (VR) tools for learning. The study used a mixed-methods design as it involved a survey with 215 undergraduate students and a follow-up

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qualitative interview. The findings of the study confirmed that learning style significantly influences students' acceptance and subjective judgment of VR as an educational technology. Results of quantitative findings revealed that there were statistically significant differences among the learning styles, with the highest level of enjoyment and perceived usefulness reported by kinesthetic and visual learners. Qualitative analysis also supported the findings of quantitative data by extracting out the themes like "Feeling of Presence" and "Mismatch with Learning Preference".

The present study not only contributes in the field of learning style theory and the technology acceptance models, but also emphasize on mindful integration of technology keeping in view individual differences and various learning styles. Although implementation of VR has promising opportunities in terms of boosting engagement and learning outcomes for students, but while designed it, this point must be kept in mind that it should meet the variability in students' learning preferences.

In conclusion, we can say that this study has highlighted the transformative potential of VR in education but it must align with the learning style of leaners to become more effective. An understanding and consideration of these differences will help practitioners to develop more inclusive and effective learning spaces.

References

- Allcoat, D., & von Mühlenen, A. (2018). Learning in virtual reality: Effects on performance, emotion and engagement. *Research in Learning Technology, 26*. https://wrap.warwick.ac.uk/id/eprint/110897/
- Bailenson, J. (2018). Experience on demand: What virtual reality is, how it works, and what it can do. W. W. Norton & Company.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa
- Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008
- Fleming, N. D., & Mills, C. (1992). Not another inventory, rather a catalyst for reflection. *To Improve the Academy, 11*(1), 137–155.

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- Hamilton, D., McKechnie, J., Edgerton, E., & Wilson, C. (2021). Immersive virtual reality as a pedagogical tool in education: A systematic literature review of quantitative learning outcomes and experimental design. *Journal of Computers in Education, 8*(1), 1–32. https://doi.org/10.1007/s40692-020-00169-2
- Huang, C. L., Luo, Y. F., Yang, S. C., Lu, C. M., & Chen, A. S. (2020). Influence of students' learning style, sense of presence, and cognitive load on learning outcomes in an immersive virtual reality learning environment. *Journal of Educational Computing Research, 58*(3), 596–615. https://doi.org/10.1177/0735633119867422
- Jensen, L., & Konradsen, F. (2018). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies, 23*(4), 1515–1529. https://doi.org/10.1007/s10639-017-9676-0
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall.
- Leite, W. L., Svinicki, M., & Shi, Y. (2010). Attempted validation of the scores of the VARK: Learning styles inventory with multitrait–multimethod confirmatory factor analysis models. *Educational and Psychological Measurement, 70*(2), 323–339. https://doi.org/10.1177/0013164409344507
- Makransky, G., & Lilleholt, L. (2018). A structural equation modeling investigation of the emotional value of immersive virtual reality in education. *Educational Technology Research and Development, 66*, 1141–1164. https://doi.org/10.1007/s11423-018-9581-2
- Makransky, G., Terkildsen, T. S., & Mayer, R. E. (2019). Adding immersive virtual reality to a science lab simulation causes more presence but less learning. *Learning and Instruction, 60*, 225–236. https://www.sciencedirect.com/science/article/pii/S0959475217303274
- Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education, 70*, 29–40. https://doi.org/10.1016/j.compedu.2013.07.033
- Parong, J., & Mayer, R. E. (2018). Learning science in immersive virtual reality. *Journal of Educational Psychology, 110*(6), 785–797. https://psycnet.apa.org/record/2018-03101-001

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- Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles: Concepts and evidence. *Psychological Science in the Public Interest, 9*(3), 105–119. https://doi.org/10.1111/j.1539-6053.2009.01038.x
- Pottle, J. (2019). Virtual reality and the transformation of medical education. *Future Healthcare Journal, 6*(3), 181–185. https://doi.org/10.7861/fhj.2019-0036
- Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education, 147*, 103778. https://doi.org/10.1016/j.compedu.2019.103778
- Shen, C. W., Ho, J. T., Ly, P. T. M., & Kuo, T. C. (2019). Behavioural intentions of using virtual reality in learning: Perspectives of acceptance of information technology and learning style. *Virtual Reality, 23*(3), 313–324. https://doi.org/10.1007/s10055-018-0348-1
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425–478. https://doi.org/10.2307/30036540

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