Virtual Reality Tilt Brush For Creativity: An Experimental Study Among Architecture Students

Christena Stephen , Biju Kunnumpurath

ORCID: 0000-0002-9189-1712, 0000-0003-3204-6559
Email: christena.stephen@res.christuniversity.in, frbiju@christuniversity.in Christ University, Bangalore, Indi.

This study intends to comprehend the effect of the Tilt Brush (TB) Virtual Reality 3D Painting application on creativity among final year architecture students. The research was done over the course of 30 hours, evaluated the performance of a group of 20 university students. Using a Structured Observation Form (SOF), the researcher assessed the research's progress. Four recently graduated artists, educators, and researchers used a Rubric to assess student designs. During the training, the study group was instructed in the fundamentals of virtual reality, design principles, and TB. The design process, which began with the construction of a 3D design, progressed with the addition of texture, color, and script to items and culminated in the creation of a finished project. The group in the design process is rated as "Good" by the researcher based on feedback from SOF. The creativity evaluation Rubric used by the experts rates their work as "Accomplished." According to the researcher's assessment, the group received a "Good" rating. Based on these findings, it can be said that include virtual reality 3D painting in the curriculum for art and design classes will help students improve their imagination and creativity as well as their 21st century skills.

Keywords: *Creativity, virtual Reality, 3D Painting, Tilt Brush.*

1. Introduction

Led to advancements in computer hardware and software, new technologies are routinely used to improve student learning. Virtual reality (VR) is one such technology that has experienced continual development, produced a wide range of applications, and is used by educators and instructional designers to support student learning. Virtual reality's two main tenets are immersion and presence (Ho, 2019). Users of virtual reality (VR) are immersed in an

immersive environment by means of a head-mounted display, which also offers rich visual experiences and a sense of presence (Alex, 2021). Immersive storytelling, interactive reading, and virtual painting using three-dimensional models are just a few examples of the meaning-making potentials and affordances that virtual reality (VR) technologies are quickly becoming more widely available in homes and schools (Mills, 2022). Virtual reality technology being one of the significant mediums for the updating of the animation art form in the future era of artificial intelligence, its combination will enable it to accommodate people more effectively' varied experiences and unique needs (Liu, 2021). Most students in the digital media design programme are skilled in drawing and designing in two dimensions. However, they must first visualize 3D space on a 2D computer screen in order to learn how to construct 3D animations; as a result, the capacity to reimagine spaces in various dimensions is crucial for being able to create 3D animation. By using 3D models to simulate the real world and allowing users to fully immerse themselves in interactions with 3D models, these learning environments can stimulate users' imaginations. (Ho, 2019).

Humans have always tried to visually portray and recreate the world since the beginning of existence. Recent years have seen a large-scale adoption of the transition of imaging techniques from traditional media to 3D scanning as a new representation method with generated digital data, especially in the creative element. This is due to technological advancement and computational visualization (Tin, 2020). To understand the significance of art and the difficulties that comes with studying it, one simply needs to consider the broad history of art as well as the ever-expanding diversity of artists and visual mediums. Since the dawn of human society, those who had a talent for creating visual images have likely been highly valued (Pelowski, 2017). 3D animation is an essential tool for producing visual content for applications ranging from virtual reality (VR) to augmented reality (AR). Due to market and industry expectations, students in related professions are now expected to have a fundamental understanding of 3D animation techniques (Ho, 2019). There are several fields where the 3D imaginary is used. Digital technology has been said to significantly contribute to promoting students' creativity by offering new tools and venues for learning to be imaginative and learning by being creative.

Virtual reality (VR) brings three primary advantages to the realm of art: firstly, it significantly amplifies the interactive and intuitive aspects of art; secondly, it substantially augments the quasi-deterministic nature of art design work, leading to reduced design expenses; and thirdly, it notably diminishes design-related risks while amplifying the practical and empirical aspects of environmental art design (Qian, 2020). Creativity, in its general definition, involves producing outcomes that are perceived as both fresh/innovative and functional/appropriate within a specific social context. Several environmental and human elements contribute to this process. Educators across various countries assert that technology has the potential to enhance both creativity and education. Recent research has emphasized the distinctive role of virtual reality environments in expanding and intensifying creativity, particularly through the utilization of imaginative avatars (Bereczki, 2021). As an innovative advancement, VR not only enriches the design experience and aids designers in actualizing art design theory, design concepts, creative ideation, and artistic expression, but it also simplifies the realization of artistic innovation through the establishment of diverse model databases.

This creates numerous fresh platforms for artistic expression, augments the design progression, and nurtures inventive talent (chang, 2019).

Students' creativity in visual arts is enhanced by technological tools (Tillander, 2011). There is a wide range of color choices available, along with the ability to incorporate text into the artistic composition. Additionally, various features encourage unfettered imagination, including three-dimensional brushstrokes, stars, light, and even fire. With this in consideration, this research has explored the influence of the TB virtual environment on creativity within the realm of art and design education. Originally developed by Skillman & Hackett, Tilt Brush is a virtual reality application for room-scale 3D painting, now offered by Google. The current version of Tilt Brush will still be available for purchase in app stores, however the app's code is open sourced and no longer supported by Google as of January 2021.

2. Materials and Methods
The following study's objectives provide insight into how the VR TB application fosters student creativity in a learning environment:

1. To comprehend the impact of Tilt Brush on the creative side of art and design education
2. What do experts think about the artistic creativity that students exhibit through the designs produced by using the Tilt Brush application in art and design classes?

Both the process and the outcome are parts of creativity. To investigate the efficacy of the creative process using the Tilt Brush method, the initial query was posed. There are many different aspects to creativity. For the conclusion of the findings, expert judgement was also required regarding whether the results of the used approach were creative or not. What the final products imply to design professionals has been a subject of speculation. In order to understand this circumstance, a second question was raised.

The data was gathered from the workshop-generated designs and the twenty-week design process, in addition to employing a rubric for evaluation.

20 students majoring in architecture made up the study group for the project. 6 men and 12 women who were all final-year architecture students took part in the study. For this study group, the "Typical Case Sampling" method was employed. When a researcher wants to demonstrate how a certain variable impacts the student population and they decide to focus on the average students in the student population, they can utilize typical case sampling, a type of purposive non-probability sampling.

Architecture department, Christ University's Kengeri Campus in Bangalore offers Virtual Reality 3D technology for use in educational frameworks, and it was offered as an elective course that is open to all final year students. The purpose of the course, "Virtual Reality & Digital Drawing skills," was to introduce the participants to 3D virtual reality painting. The route was designed to provide everyone an equal chance to participate.

The research team collected data using their own Structured Observation Form (SOF) and the Rubric. To develop the Rubric, a thorough review of relevant literature and related sources was conducted, aiming to incorporate expert perspectives on the artistic creativity

demonstrated by students in their designs resulting from their use of TB applications and participation in art classes. Additionally, the Rubric was employed for grading and assessing these designs.

Numerous scholars have proposed diverse interpretations of creativity, encompassing it as a process, a product, or even both, depending on individual perspectives. Another perspective posits that creativity emerges from an individual's engagement within cultural and social contexts. Examples of key facets include originality and innovation. The form of creative expression examined in this study shares a common attribute that augments both the production process and its outcomes. Scholars such as Wallas, Guilford, and Torrance espouse definitions of creativity that align with the one adopted in this research. According to their characterizations, creativity encompasses activities such as identifying problems, generating solutions, employing both divergent and convergent thinking, self-expression, exercising critical thinking, generating new content, adapting to novel circumstances and participating actively in the learning journey.

In this context, a Rubric was developed to assess students' performance across five key areas: "Design" "Technical Skills," and " Information and Perception Capacity," "Self-Evaluation Capacity" & "Research and Study Approach,". Once these criteria were established, their definitions and descriptions were carefully scrutinized. Subsequently, performance standards and proficiency levels expected from students were set by clearly outlining these components. Each criterion was scored on a scale from 1 to 5. Ratings within the range of 0 to 5 were categorized as 'Needs Improvement,' 6 to 10 as 'Satisfactory,' 11 to 15 as 'Good,' and 16 to 20 as 'Accomplished,' based on assessments using the Structured Observation Form (SOF) and the Rubric.

Regarding the evaluation of scores for . "Design" "Technical Skills," and " Information and Perception Capacity," as well as their cumulative total, the researcher applies the following criteria: Scores in the range of 0 to 1.49 are assessed as 'Needs Improvement,' 1.50 to 2.49 are categorized as 'Satisfactory,' 2.50 to 3.49 are deemed 'Good,' and 3.50 to 4.00 are recognized as 'Accomplished.'

The five titles in the rubric and the Structured Observation Form (SOF) are listed below.

1. In the Tilt Brush environment, the student's understanding of online 3D, multiple users virtual environments, knowledge of procedures and ways to create an objects, and knowledge of exhibition space are evaluated using their "information and perception capacity."
2. By examining the students' proficiency with various tools and methods, particularly considering their aptitude for design, the "technical skills" of the students have been assessed.
3. Through the students' output, it was discerned that incorporating emotive attributes and unconventional yet effective application of visual design principles led to the development of outstanding exhibition designs within a virtual environment.
4. It has been determined that the "research and study approach" has improved students' capacity to fulfill all obligations related to the learning process within the allotted time.
5. The students' ability to present a nuanced critical perspective towards their own designs was evaluated through the criterion of 'Self-evaluation capacity'.

The Rubric was adapted from a study of a similar nature that sought to expose the impacts of the Second Life (SL) programme used in a virtual environment on the teaching of creativity in art and design. After it was given to three subject-matter experts and one assessment and evaluation specialist, they developed the Rubric. The experts' opinions were taken into consideration when shaping the final version of the Rubric. The rater-to-fit index was used to ensure the reliability of the scoring system and Rubrics which is adopted from the study (Ceylan, 2020).

Investigating how the TB application influences the learning experience in art and design classes, the researcher utilized the same criteria employed in the Rubric's development, relying on the Structured Observation Form (SOF) during the implementation phase. This approach was instrumental in addressing the inquiry. The SOF was intentionally fashioned to delineate the influence of the TB virtual environment on the creative aspects of art and design education. Throughout this endeavor, the researcher actively assumed the role of a 'participant observer'.

The class was split into four groups, and it lasted 30 hours. The students spent the first 16 hours learning the basics of virtual reality and design principles, while the final 12 hours were spent working on 3D virtual reality artwork. Before being asked to reproduce in 3D, the pupils were requested to draw in 2D first. Experts in art and design analyzed the information gleaned from students' artistic creations.

3. Results

This qualitative study focuses on the evaluation of designs through the utilization of structure observation form (SOF) and a Rubric. This data collection instrument facilitates the numerical categorization of qualitative data. Percentage and frequency values are employed in this research to delineate the SOF and Rubric scores. Subsequently, these numerical representations are subject to interpretation.

To accomplish the research objective, the data and findings were organized into two primary categories, each addressing a specific research question.

1. The impact of the Tilt Brush application method on creativity.
2. Expert views on Tilt Brush application for fostering students artistic creativity.
    3.1 The impact of the Tilt Brush application method on creativity.
    3.1.1 Rubric ratings made by researchers

The researcher analysed each participant's designs in order to show how students' creativity has evolved in relation to the designs produced by using the Tilt Brush approach.

Table 1 Researcher Creativity Rubric Evaluation Results

Stude nt No.	Informati on & perceptio n capacity	Technic al skills	Desig n	Researc h & study approac h	Self- evaluati on capacity	Tota l scor e	Mea n	Quality
1	3	3	3	2	2	13	2.6	Good
2	3	3	3	2	2	13	2.6	Good

3	3	3	3	1	1	11	2.2	Good
4	3	3	2	2	2	12	2.4	Good
5	3	3	2	2	2	12	2.4	Good
6	3	3	3	1	1	11	2.2	Good
7	3	3	3	2	2	13	2.6	Good
8	4	3	3	3	3	16	3.2	Accomplished
9	4	3	3	3	3	16	3.2	Accomplished
10	4	3	3	3	3	16	3.2	Accomplished
11	4	3	2	3	4	16	3.2	Accomplished
12	4	4	3	3	3	17	3.4	Accomplished
13	4	4	3	3	3	17	3.4	Accomplished
14	4	4	3	3	3	17	3.4	Accomplished
15	4	3	3	4	4	18	3.6	Accomplished
16	4	3	3	4	4	18	3.6	Accomplished
17	4	4	3	4	4	19	3.8	Accomplished
18	4	4	3	4	4	19	3.8	Accomplished
19	4	4	3	4	4	19	3.8	Accomplished
20	4	4	4	4	4	20	4	Accomplished

Table 1 presents the students' final scores and their averages across various domains including "Design" "Technical Skills," and " Information and Perception Capacity," "Self-Evaluation Capacity" & "Research and Study Approach,". This table provides a detailed breakdown of the criteria utilized by the researcher to assess the study group. The 'Accomplished' category consists of 13 students aged between 16 and 20, while the 'Good' category comprises 7 students with total scores ranging from 11 to 15. The calculations yielded an average total score of 15.7 with a median of 16.5. In terms of the overall score, the majority of students fall within the 'Good' classification.

3.1. 2. Researchers research method evaluation

Qualitative data is produced by using SOF to investigate the Tilt Brush method's implementation process from the participant's point of view.

Table 2 Table of Observation form

Student No.	Design Process	TB (Technical skills)	Information & Perception capacity	Research & Study Approach	Self-Evaluation Capacity	Total	Quality
1	11	11	9	14	6	51	Satisfactory
2	13	12	9	16	7	57	Good
3	11	11	9	14	6	51	Satisfactory
4	11	10	8	13	6	48	Needs Improvement
5	12	16	12	20	8	68	Accomplished
6	12	15	12	16	8	63	Good
7	10	10	9	14	6	49	Needs Improvement
8	15	16	12	20	7	70	Accomplished
9	12	11	9	14	6	52	Satisfactory
10	12	15	12	18	7	64	Good
11	11	10	9	22	6	47	Needs Improvement
12	15	16	12	30	8	71	Accomplished
13	11	15	12	20	8	66	Accomplished
14	12	15	12	18	7	64	Good
15	15	16	14	20	8	73	Accomplished
16	12	11	9	14	6	52	Satisfactory
17	12	12	11	13	6	54	Satisfactory
18	10	10	9	14	6	49	Needs Improvement
19	12	13	11	13	6	55	Satisfactory
20	11	14	11	18	7	61	Good

The evaluation of the research approach relies on the SOF data from Table 2. Table 4 compiles the scores for "Design" "Technical Skills," and " Information and Perception Capacity," Self-

Evaluation Capacity & Research & Study Approach derived from the study group's assessments. This table underscores the thorough validation of the data contained in the SOF.

According to Table 2, some students received SOF scores of 47, 48, 54, 55, 57, 61, 63, 66, 68, 70, 71, and 73, giving them a total of 75%. There are two pupils with a combined SOF of 49, 51, 52, and 64. Table 5 is observable in this situation.

Table 3 Observation form quality table

Quality	Frequency	Percentage (%)
Good	5	25
Satisfactory	6	30
Accomplished	5	25
Needs Improvement	4	20
Total	20	100

Five students are in the "Good" group, six are in the "Satisfactory" category, five are in the "Accomplished" category, and four are in the "Needs Improvement" category, per Table 3, which summarizes student performance on the SOF. 20 students' SOF scores, on average, are 58.5. The result of 58.25 is within the acceptable ranges, hence it is deemed "Good."

The students made multiple attempts to learn how to use the virtual reality tilt brush during this course plan time as they gradually acquired new skills. After creating an avatar, the design process moved on to 3D design, which gave objects color, texture, and script and resulted in the creation of a note card that summarised their work. According to SOF's findings, students may use technology, like as 3D virtual reality, to alter information in creative ways. Csikszentmihalyi and Wolfe assert that "In the future, it will be necessary to have individuals who can generate new issues, find new answers, and quickly adjust to novel concepts." Students struggled with a variety of issues, supported one another, and maintained frequent contact (Csikszentmihalyi & Wolfe, 2014, as cited in Han, 2017).
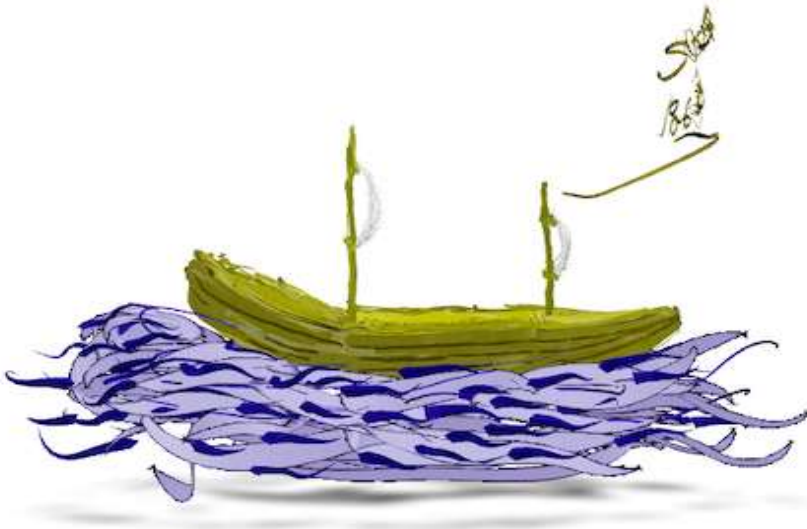
Figure 1 Student Project 7

Both the process and the outcome are important to creativity. The procedure was observed and evaluated for the outcome using SOF. The overall performance is rated as Good as a result of the examination of SOF.

3.2 Experts Expert views on Tilt Brush application for fostering students artistic creativity.

The final research question posed was, 'What are the experts' assessments of the students artistic creativity that emerges through the designs created with the utilization of the Tilt Brush Application in art and design courses?' The conclusions drawn from the Rubric, administered by both subject-matter experts and researchers, were compiled. A concise overview of the expert viewpoints on this secondary inquiry is presented in Figure 1.

Experts Opinion

Expert opinions on students improving artistic creativity through designs obtained through the use of Tilt Brush in art and design courses.

- Tilt brush Method for developing students' creativity based on obtained designs
- Students' perception and application skills based on obtained designs using the Tilt Brush Method

3.2.1. Tilt brush Method for developing students' creativity based on obtained designs

Four faculty members who are professionals in their disciplines have created a Rubric to assess each participant's level of originality, proficiency with Tilt Brush, and exhibition designs.

Table 4 Expert Creativity Rubric Evaluation Results

Student No	Expert 1	Expert 2	Expert 3	Expert 4	Total Score	Mean	Quality
1	7	12	9	12	40	10	Satisfactory
2	10	12	14	12	48	12	Good
3	10	13	12	11	46	11.5	Good
4	10	13	10	14	47	11.8	Good
5	17	18	17	20	72	18	Accomplished
6	17	18	17	20	72	18	Accomplished
7	17	19	20	20	76	19	Accomplished
8	16	17	14	16	63	15.8	Accomplished
9	18	16	13	15	62	15.5	Accomplished
10	20	18	15	20	73	18.3	Accomplished
11	20	20	17	20	77	19.2	Accomplished
12	20	20	20	18	78	19.5	Accomplished
13	18	16	14	15	63	15.7	Accomplished
14	18	16	15	15	64	16	Accomplished
15	18	17	12	15	62	15.5	Accomplished
16	17	18	17	20	72	18	Accomplished
17	20	18	15	20	73	18.3	Accomplished
18	17	19	20	20	70	19	Accomplished
19	18	16	15	15	64	16	Accomplished
20	20	18	17	20	72	18	Accomplished

The total scores from the four experts are shown in Table 4, along with the average of these scores for each of the students in the study group. None of these 20 pupils were assigned to the Needs Improvement category. 3 pupils (15%) were evaluated as Good, while 1 student (5%) were in the Satisfactory class. The 16 students who made up the 80% of the group and were in the top percentile were given the Accomplished label.

In the preceding discussion, a connection between creativity and virtual environments was established. This study utilized a Rubric, developed based on a comprehensive literature review, to assess creativity. The objective of this scale was to measure various facets of the creative process. The analytical findings from the Rubric, as evaluated by experts, clearly indicate that students classified as 'Accomplished' exhibit a notable proficiency, providing

compelling evidence that supports the premise of this study - that virtual environments have a positive influence on augmenting creativity.

3.2.2. Students' perception and application skills based on obtained designs using the Tilt Brush Method

To assess students' proficiency in perception and application skills, the means of the scores in "Design" "Technical Skills," and " Information and Perception Capacity," were computed based on the designs generated through the Tilt Brush method.

Table 5 "Design" "Technical Skills," and " Information and Perception Capacity," Scores Mean Values

Student No	Information and Perception capacity	Technical skills	Design	Total	Mean	Quality
1	3	3	3	9	3	Good
2	4	3	3	10	3.3	Good
3	4	3	3	10	3.3	Good
4	4	3	4	11	3.7	Accomplished
5	4	3	4	11	3.7	Accomplished
6	4	3	4	11	3.7	Accomplished
7	4	3	4	11	3.7	Accomplished
8	4	3	4	11	3.7	Accomplished
9	4	4	3	11	3.8	Accomplished
10	4	4	3	11	3.8	Accomplished
11	4	4	3	11	3.8	Accomplished
12	4	4	3	11	3.8	Accomplished
13	4	4	3	11	3.8	Accomplished
14	4	4	4	12	4	Accomplished
15	4	4	4	12	4	Accomplished
16	4	4	4	12	4	Accomplished
17	4	4	4	12	4	Accomplished
18	4	4	4	12	4	Accomplished
19	4	4	4	12	4	Accomplished
20	4	4	4	12	4	Accomplished

Participants' ratings for "Design" "Technical Skills," and " Information and Perception Capacity," together with their respective totals, as viewed from the researcher's perspective is presented in Table 5. With 3 students scoring on average between 2.50 and 3.49 for "Design" "Technical Skills," and " Information and Perception Capacity," a total of 15% and a "Good" average were the result. 17 students with scores between 3.50 and 4.00 produce an average of "Accomplished," or 85%.

Figure 2 Student Project 18

Figure 3 Student Project 15

4. Discussion

Technology-assisted art integration is inextricably linked to the ongoing advancement of human knowledge and technology. The development of technology reflects both human wisdom and humanity's never-ending search of unexplored territory (Hu, 2023). Virtual immersion may express emotional qualities more vividly than any other kind of media and give individuals an illusion and an experience like no other , makes abstract ideas more concrete, enables learning through application and experimentation, and supports a constructivist learning style (Beaumier, 2023) and provides motivation (Kumar, 2023).

Employing digital technology is another approach to establish a contemporary learning environment. Digital resources engage students' curiosity, aiding in information retention. The incorporation of digital technologies not only stimulates participant motivation and interest but also accommodates diverse learning styles, emphasizes creative potential, and cultivates proficiency in modern information technology to align with the experiential age. This, in turn, contributes to the enhancement of educational standards (Karakozov, 2019). In this study, the aim is to explore the relationship between creativity and art and design education through the utilization of a 3D painting tool called 'Tilt Brush.' Qualitative methodologies were employed, and data were collected from the Statements of Findings (SOF) and Rubric scores of 20 students. Based on the classification of SOF and the Rubric results, a descriptive interpretation was formulated.

The following are the challenges presented by (Stephen, 2022) on adopting virtual reality in educational settings: Compared to traditional approaches, it necessitates significant resource expenditures, an orientation process, and more time for implementation. Additionally, because of environmental attraction, students may occasionally become engaged

in activities that are not educationally beneficial. It is feasible to infer from these considerations that the difficulties faced throughout the course of this research included the orientation phase, the time required for execution, the virtual setting (for creation), the cost (Checa, 2023), and an unsatisfactory internet connection (Figueroa, 2023).

The following list enumerates the learning outcomes achievable through the use of the Tilt Brush (TB) environment in higher education and art and design curricula. Research suggests that virtual reality (VR) has the capacity to heighten learning motivation and engagement (Huang et al., 2016; Roussou, 2004). The application of Tilt Brush for crafting 3D designs elicited positive emotions such as excitement, joy, and a notable sense of satisfaction among participants (Haeyen, 2021). Positive sentiments were observed to stem from 20 minutes of VR art-making in two small-scale pilot tests employing Tilt Brush (Kaimal, 2020). This positively impacted creativity, expanded imaginative thinking, facilitated interaction, and encouraged problem-solving. Consequently, virtual reality (VR) holds promise in bolstering mental health and overall well-being.

The study demonstrated that the rapid 3D VR capabilities of the virtual reality Tilt Brush had both psychological and physical effects (Schaaf, 2019). A room-scale virtual reality system, offering six degrees of freedom (6-DoF VR), was employed to generate three-dimensional artworks through the utilization of Google Tilt Brush, providing students with an immersive experience in a virtual environment. Due to the immersive nature of the virtual world, users could focus on their visual perception and spatial orientation to differentiate between 2D and 3D artworks (Google, 2018).

The incorporation of 3D virtual environments into art and design classrooms is believed to be instrumental in fostering 21st-century skills, as convincingly argued by Mike Wadhera(Wadhera, 2016) that VR offers a medium for individuals to exchange and gain insights from one another's experiences (Diwan, 2018). Throughout this study, participating students demonstrated a wide range of output, discussions, and creative abilities. Consequently, students require proficiency in both virtual world learning and the creation and discussion of virtual media. Moreover, they utilized pre-existing productions and the Tilt Brush (TB) environment to generate content. The research conducted here is in alignment with Allen's work on 'VR as a constructivist approach to experiential learning' (Aiello, 2012).

5. Conclusions

It may be asserted that students today are adept at using digital settings and tools for knowledge discovery, development, and creative transformation. What impact does the use of the TB application have on the learning process of art and design for participants? Here are specifics on the outcomes of the Structured Observation Form and Rubric analyses. It appears possible to say in response to this query that education in virtual settings fosters creativity. A Rubric was used to gauge how much students' creativity was progressing. Four faculty members used Rubrics to assess participants' TB skills, exhibition designs, and levels of creativity. The fact that none of the participants are in the "Needs Improvement" class and that a sizable portion of them are in the "Accomplished" class, as can be seen from this assessment, indicates that the design studies produced by using the TB approach have a high level of originality.

The researcher utilized a rubric to assess each participant's design, aiming to gauge the enhancement of students' perception and application skills. The researcher determined the attributes of each participant by averaging scores in the categories of . "Design" "Technical Skills," and " Information and Perception Capacity,". These designs were created using the TB method. The researcher's evaluations placed the participants in the 'Good' category. Based on the comprehensive Rubric study, it is evident that the query regarding 'What are the experts' opinions on the artistic creativeness that emerges in participants through the use of Tilt Brush Application in art & design courses?' can be affirmatively addressed in favor of teaching art & design. However, it is important to note that further research findings exploring the connection between the 3D environment and creativity are essential to substantiate this conclusion.

Ethical considerations
Not applicable

Conflicts of Interest
The authors declare no conflicts of interest.

Funding
This research did not receive any financial support.

References
1. Aiello, P. A. O. L. A., D'Elia, F. R. A. N. C. E. S. C. A., Di Tore, S. T. E. F. A. N. O., & Sibilio, M. (2012). A constructivist approach to virtual reality for experiential learning. E-learning and Digital Media, 9(3), 317-324.
2. **Alex, M., Wünsche, B. C., & Lottridge, D. (2021). Virtual reality art-making for stroke rehabilitation: Field study and technology probe. International Journal of Human-Computer Studies, 145, 102481.**
3. Beaumier, A., & Koole, M. (2023). Augmented and virtual reality in the classroom: Adding a postdigital perspective to backward design lesson planning. In Immersive education: Designing for learning (pp. 31-50). Cham: Springer International Publishing
4. Bereczki, E. O., & Kárpáti, A. (2021). Technology-enhanced creativity: A multiple case study of digital technology-integration expert teachers' beliefs and practices. Thinking Skills and Creativity, 39, 100791.
5. Ceylan Dadakoglu, S., & Özsoy, V. (2020). Second Life Application for Creativity in Art and Design Education. International Journal of Educational Methodology, 6(4), 759-773
6. Chang, Y. S., Chen, M. Y. C., Chuang, M. J., & Chou, C. H. (2019). Improving creative self-efficacy and performance through computer-aided design application. Thinking Skills and Creativity, 31, 103-111.
7. Checa, D., & Bustillo, A. (2023). Virtual Reality for Learning.
8. Diwan, P. (2018, June 19). Virtual Reality set to transform Education - Parag Diwan. Medium. https://pdiwan.medium.com/virtual-reality-set-to-transform-education-6e7f8480d9c9.

9. Figueroa Jr, R. B., Gil, F. A. A. P., & Taniguchi, H. (2023). Piloting virtual reality photo-based tours among students of a Filipino language class: A case of emergency remote teaching in Japan. arXiv preprint arXiv:2301.01904.

10. Google Tilt Brush. Available online: **https://www.tiltbrush.com/** (accessed on 2 December 2018).

11. Haeyen, S., Jans, N., & Heijman, J. (2021). The use of VR tilt brush in art and psychomotor therapy: An innovative perspective. The Arts in Psychotherapy, 76, 101855.

12. Han, H. C. S. (2017). Virtual world and creativity. Journal of Virtual Studies, 8(2), 12-22.

13. Ho, L. H., Sun, H., & Tsai, T. H. (2019). Research on 3D painting in virtual reality to improve students' motivation of 3D animation learning. Sustainability, 11(6), 1605.

14. Hu, Z., & Liu, L. (2023). Research on the application of virtual reality technology in 3D animation creation. Optik, 272, 17027

15. Huang, H.-M., Liaw, S.-S., & Lai, C.-M. (2016). Exploring learner acceptance of the use of virtual reality in medical education: A case study of desktop and projection-based display systems. Interactive Learning Environments, 24(1), 3–19.

16. Kaimal, G., Carroll-Haskins, K., Berberian, M., Dougherty, A., Carlton, N., & Ramakrishnan, A. (2020). Virtual reality in art therapy: a pilot qualitative study of the novel medium and implications for practice. Art Therapy, 37(1), 16-24

17. Karakozov, S. D., & Ryzhova, N. I. (2019). Information and education systems in the context of digitalization of education. Журнал Сибирского федерального университета. Серия: Гуманитарные науки, 12(9), 1635-164

18. Kumar, A., Srinivasan, B., Saudagar, A. K. J., AlTameem, A., Alkhathami, M., Alsamani, B., ... & Singh, K. U. (2023). Next-Gen Mulsemedia: Virtual Reality Haptic Simulator's Impact on Medical Practitioner for Higher Education Institutions. Electronics, 12(2), 356.

19. Liu, H. (2021, February). Application and Development of VR Technology in Painting. In Journal of Physics: Conference Series (Vol. 1744, No. 4, p. 042225). IOP Publishing.

20. Mills, K. A., & Brown, A. (2022). Immersive virtual reality (VR) for digital media making: transmediation is key. Learning, Media and Technology, 47(2), 179-200.

21. Obeid, S., & Demirkan, H. (2020). The influence of virtual reality on design process creativity in basic design studios. Interactive Learning Environments, 1-19.

22. Pelowski, M., Leder, H., & Tinio, P. P. (2017). Creativity in the visual arts. The Cambridge handbook of creativity across domains, 80-109.

23. Qian, J. (2020, April). Application of VR in art design. In Journal of Physics: Conference Series (Vol. 1533, No. 2, p. 022004). IOP Publishing.

24. Roussou, M. (2004). Learning by doing and learning through play: An exploration of interactivity in virtual environments for children. Computers in Entertainment (CIE), 2(1), 10.

25. Schaaf, A. (2019). Tilt Brush: The Utilization of a Virtual Reality Intervention for Evaluating Self-Reported Anxiety, Depression, & Stress (Doctoral dissertation, University of Cincinnati)

26. Stephen, C. (2022, December). Exploring 3D painting and Joyful learning with Virtual Reality Tilt Brush. European Journal of Molecular & Clinical Medicine, 10 / 1 / 1653-1671.

27. Tin, M. L. M. (2020). 3D scanning and visual dimension–Technological and creative evolution. In Advances in Human Factors in Communication of Design: Proceedings of the AHFE 2019 International Conference on Human Factors in Communication of Design, July 24-28, 2019, Washington DC, USA 10 (pp. 130-137). Springer International Publishing.

28. Tillander, M. (2011). Creativity, technology, art, and pedagogical practices. Art Education, 64(1), 40-46.