The Effects of Virtual Reality on Information Retention

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Abstract. This paper presents "The Tales of Antiquity: The Virtual Gallery," an educational project by The Effects of Virtual Reality on Information Retention Group. This is aimed at enhancing information retention through the use of digital education. This project constructs an immersive virtual world that narrates the history of Vincent Van Gogh. By utilizing different digital storytelling formats such as an article format, slideshow presentation, and virtual reality, this project demonstrates how technological advances impact learning outcomes and provide alternative learning methods. This study will involve a detailed experiment with 34 participants, ranging in age from 20 to 60, to evaluate the effectiveness of varied storytelling methods on learning outcomes, as well as evaluate their enjoyment of the experience and their thoughts on the validity of it. Participants will be divided into three groups, each experiencing the narrative through a distinct format: a traditional reading article, a slideshow presentation, and an immersive virtual reality (VR) experience. The aim of this research is to contribute significant insights into the fields of educational psychology, human-computer interaction, and multimedia learning by exploring diverse modalities. The project's findings are expected to shed light on the most effective digital storytelling techniques and help us understand how technology can be best utilized to enhance educational engagement, improve information retention, and explore learning styles.

CCS Concepts: • **Virtual Reality Learning**; • **Virtual Reality Information Retention**; • **Multimedia Learning**; • **Multi-modal Interaction**;

Additional Key Words and Phrases: Virtual Reality, Multimedia Learning, Information Retention, Multi-modal interaction

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1 INTRODUCTION

In the dynamic landscape of education, the emergence of digital technologies offers unprecedented opportunities for enhancing learning experiences. Our group is driven by the desire to uncover how different digital educational methods influence information retention. To tackle this, we're crafting a virtual realm that brings Vincent Van Gogh's life and art to vivid life. Our project aims to dive into this realm. Through an interactive and immersive virtual environment, participants will embark on a journey into Vincent Van Gogh's life and his art throughout it.

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Our motivation stems from a recognition of the gap between traditional educational approaches and the vast potential offered by digital platforms. As technology continues to grow and develop, the ways we share and retain information evolve. By investigating the impact of various digital learning methods, including a written document, virtual reality (VR), and a PowerPoint presentation, our study aims to address the evolving landscape of educational technology. As technology advances, so too must our understanding of how to harness its potential for optimizing learning outcomes.

Understanding the influence of digital education on information retention is paramount for shaping the future of learning. Our research aims to contribute valuable insights to this ongoing dialogue, facilitating the evolution of educational practices in the digital age.

2 RELATED WORKS

Digital education and multimedia learning have developed alongside the growth of technology. There are numerous ways of presenting information that can change how a person learns. Nowadays, digital media is often the primary presentation of information in academia, as well as in everyday life. In *Multimedia Learning* by Richard E. Mayer, he discusses twelve principles that are vital when presenting information through media. [24] For our study we focused on the multimedia principle, modality principle, and the voice principle. The multimedia principle claims that people learn better from words and pictures than from words alone. [24] The modality principle claims that reducing the use of text and relying more on imagery and voice-over can improve deeper learning. [24] The voice principle claims that using natural human voices as opposed to text-to-speech can improve learning. [24] These principles were taken into account when developing our forms of information presentation. In a study conducted by April Savoy, Robert W. Proctor, and Gavriel Salvendy in *Computers and Education* they interviewed 62 students who were present for an audial traditional lecture with no presentation and for a PowerPoint-driven lecture. [32] Students affirmed that they did prefer PowerPoint lectures over traditional presentations. In another study, it was found that students preferred PowerPoint-based lectures and performed best when it was accompanied by images. [7] Images are often crucial for how people interact with the content they are learning from. There are studies that report the effectiveness of images for young children when reading. [14] Further studies express the importance of images when making connections to the text. Utilizing a relevant image allows students to connect information presented through text with an imagery representation [8] This connection of imagery to text is effective in groups of all ages. In *Reading Comprehension* Merlin Wittrock examines what strategies people of all ages use to retain information. When reading or collecting information people relate the information to things they are familiar with already. [39] This applies to images as well. By presenting students with relevant imagery while learning new information it provides another point of reference for the student to relate information to. PowerPoint-style presentations have been proven to be effective, so why would we explore further than this form of education?

There are benefits to exploring different styles of learning as many people have different preferred styles. Learning styles can be divided into Visual/Graphic, Aural, Read/Write, and Kinesthetic types. [2] There remains a large debate about the effectiveness of employing different learning styles in a classroom setting. In *Survey of Research on Learning Styles* the authors provide a comparison of multiple studies regarding learning styles. From their collection, they imply that altering the curriculum to match a student's style or needs can lead to improved academic results. [10] In another study conducted in *Learning Styles: Concepts and evidence* the group concluded that there was not sufficient evidence to support incorporating learning styles into general educational practice. [28] Although it might not directly impact a students performance, it might improve their learning experience and willingness to study certain material. In another study, it was found that when given the opportunity students prefer multimodal and more kinesthetic types of

learning. [2] Despite being recognized as one of the major types of learning, kinesthetic learning receives much less support and employment within the classroom, especially in college courses which typically favor audio and visual learning. Joe Tranquillo provides a survey in *Kinesthetic Learning In The Classroom* in which students reacted positively to having active class participation. Using a Likert scale on average students answered a 4.8/5 that activities keep energy levels high, and a 4.6/5 for helps recall information on the test. [38] This survey shows that students enjoy active learning and feel that it is helpful for them when trying to remember information. In *Ditching the Desks: Kinesthetic Learning in College Classrooms* Kayce Mobley and Sarah Fisher provide some examples of easy in-person class activities that promote kinesthetic learning. These activities promote class movement and discussion amongst peers. [26] In another study a team of students utilized an Xbox Kinect device to allow users to interact with cartesian coordinates and plot. They found that students found the application enjoyable and found it to be a memorable experience. [6] The goal of kinesthetic learning is to promote enjoyment, engagement, and immersion in the experience.

Promoting enjoyment in education is intended to improve the overall experience students have while learning topics. In *A hierarchical conceptualization of enjoyment in students* the authors evaluated how presenting information in ways consistent to a person's preferred learning style had a benefit in the enjoyment that students had with the learning experience. [11] By allowing students to learn in their preferred learning style it is proven to improve their learning experience and bring them more enjoyment from the experience. This is further supported in another study which allowed students to participate in different learning-style-focused activities. They found that students aligned with a particular style were more inclined to participate in similar activities, and the students claimed to have had higher enjoyment levels when participating in them. [33] In a study conducted by Joanna Hernik and E. Jaworksa they found evidence that supported the claim that students remembered more information from learning experiences that they identified as enjoyable. [1] Additionally, they found that relaxing or funny lectures had a much more positive reaction from students and more students claimed to feel more comfortable about the level of information they retained. [1] An important factor in promoting enjoyment is its connection to engagement. In a study evaluating adult learning they found that enjoyment helped promote engagement and motivation to participate in the learning activities. [22] By keeping students engaged and enjoying a learning experience it might be able to foster a more positive mindset about learning a new topic and to improve the learning experience for students.

Another important aspect to explore is the effects of interactive education on academic success and information retention. As technology has developed, the possibilities for this have expanded greatly. A study that detailed the impacts of online learning and an increase in intractable web-based learning programs expressed hope for improving accessibility and allowing for students unable to attend physically to partake in courses. [5] This starts to highlight some of the initial applications of the Internet in education. This has improved over time, and now the internet is widely used as the main connection for education. Another study highlights the use of a new tool that visualizes the molecular structure of elements and allows students to interact and inspect it visibly. They found that the interactive tool helped students understand the structure and layout of elements and compounds. [34] The interactive nature of the new tools made possible by developments in technology provides new avenues of learning for students and in some cases can improve their understanding of the material. Another improvement made possible from interactive learning is that students are able to personalize their experience. In another study, it was found that if given the opportunity, many students will have differing time spent on material. Many students can spend much longer on a subject to feel comfortable about it. [35] In applications of higher education there is support for similar interactive education technologies. Nadezha O. Yakovleva describes different interactive methods in the context of preparing people for employment roles. One method they describe is action learning which entails students interacting with one another

to find who creates the best solution. [40] There are many methods of improving the interaction of education. This interaction can be with the content itself, with fellow classmates, or even improving interaction with the teacher. This keeps students engaged and allows them to have personal control over their own education.

The idea of using VR in education has existed for a long time, but it has never been pursued with great effort in public institutions for a multitude of reasons. Even before VR had become as common as it has become today there was discussion of what it could do for education. In 1992 Sandra Helsel analyzed how this interaction could be utilized in *Virtual Reality and Education*. She presented several hurdles that could impact its integration including the public orientation to virtual reality, and the timeframe of VR becoming more available. [13] Authors Mustafa Hussein and Carl Nätterdal explored this in *The Benefits of Virtual Reality in Education - A Comparison Study*. In their study, they used two modalities of presenting information to students one of which was VR and the other was a mobile app. The students explored the solar system and learned about it. They found that students greatly enjoyed the VR experience and thought it was a good way of presenting information to people. [15] Many students praised the immersive experience and proclaimed that the active learning experience assisted in them being interested and staying engaged. A similar study was conducted with a follow-up to assess whether interaction techniques providing different degrees of freedom influence users' ability to learn tasks. [25] Today VR is far more accessible and available than in the past. There are even applications designed for phones to allow for virtual experiences. As this technology progresses there is more opportunity to explore this avenue of learning. Ryan Lege and Euan Bonner explore some more modern hurdles and how VR has progressed throughout the years for education in *Virtual Reality in Education: The Promise, Progress, and Challenge*. They describe that there has been an increase in the utilization of VR in education for areas such as Engagement, Spatial Memory, Empathy Training, and Distance Learning. [19] These are all interesting avenues to explore for VR learning and engagement is extremely important for the future of VR in education. If VR can improve engagement and information retention it could become a recognized path of learning. Some challenges that still affect the efficacy of VR include motion sickness, public opinion of VR, and the cost of devices. [3] Although prices for devices have gone down and there are far more options available today it does not change the fact that a device is needed and depending on the VR experience a certain amount of graphical processing power is still required as well. However, with the introduction of far cheaper options such as the Google Cardboard, there are possibilities for headsets as low as $15. [9] Going along with the study of information retention, does experiencing art in VR or AR compare to the real thing? [20] In this study they researched exactly that, seeing if people experienced more emotion or less emotion when experiencing art in VR compared to seeing it physically outside of VR. It was found that there was no significant difference under the conditions given, indicating that in VR and physically the paintings are the same. Another proposed use of VR in higher education is for it to be used as a "rooting" experience. Oftentimes as education progresses the concepts become more theoretical and more complex. They found that many students thought the experience was helpful in forming a stronger baseline of understanding. [31] In a comparison study in which participants used VR, desktop, and hands-on conditions to learn, it was found that all participants performed similarly from pre-test to post-test after learning in their respective environments. [23] There are many ways that VR can be used for educational purposes. It can be used in conjunction with standard learning techniques, or in some cases possibly as the main form of learning.

Another aspect of learning we wanted to explore was cognitive load. Cognitive load is about the amount of information that someone can process at a time. Newly introduced knowledge must first be developed into working knowledge before it is converted and stored in long-term knowledge. [36] First, we will look at cognitive load in standard multimedia learning. Multimedia learning increases the stimulus presented to the learner. In one study 94 cognitive load articles

were surveyed and found evidence that computer and web-based learning environments were preferred in contrast to standard multimedia learning environments. [27] These environments are more contained and have less stimulus than large slideshow presentations including large class sizes, text, audio, imagery, and more. A study conducted to evaluate Virtual Reality's efficacy as an estimator for cognitive load found that cognitive load in VR was similar to real-life cognitive load when experiencing similar environments. [4] This is very interesting information. If the effects of VR do not strain the cognitive load of the participant more than a similar environment in reality, then building VR environments can be based on standard cognitive load claims.

One way to reduce cognitive load is to segment the way information is being presented. This allows students time to process the information presented to them. [21] Another aspect to consider when reducing cognitive load is subtitles. In many cases, subtitles can be assumed as necessary, such as when watching something in a foreign language. In a study conducted to evaluate the benefits and negatives of subtitles in multimedia learning, it was found that depending on the speed of the subtitles, learners will be inclined to focus more on text, or more inclined to focus on the imagery being displayed. [17] This has many implications for how users focus on the content they are learning from. If the subtitles are necessary then they must obviously be included, but if unnecessary it could lead to distractions from the learner. Cognitive load is often dependent on the learner. Different people are capable of handling varying amounts of cognitive load. [30] Many of the tactics used to reduce cognitive load focus on segmenting the presentation of information and allowing learners time to process the data they have been presented. Furthermore, reducing unnecessary distractions also helps reduce cognitive load.

There are already many modern-day applications of VR in an educational setting. A common and well-known application is in pilot training. In a study conducted by Ryan Guthridge and Virginia Clinton-Lisell, they found that pilots who trained with a VR application performed well on the post-test, and expressed they felt more prepared. [12] This is a real application of VR in an educational setting and its use is conducive to training for the real experience. Another application is in health care. In a review of multiple VR and AR studies in healthcare, it was found that there was a non-significant (p=0.052) trend toward associating VR with improved outcomes. This was in addition to a majority of studies reporting a positive reception of VR in this application. [37] Although the findings were not enough to provide a fully significant result, it shows a trend of VR being received positively. In another study, an application named Construct3D allowed students to be immersed in a geographical space. The participants expressed interest and enjoyment of the program. [16] Another article describes the possibility of 360-degree VR videos as an application for education. They surveyed many other articles and found evidence of 360-degree videos being used in multiple healthcare, STEM subjects, engineering, and environmental applications for education with positive responses. [29] A recent study discussed applications of using a metaverse to hold virtual classrooms with students. They expressed that holding VR classrooms might allow for class meetings and immersion when being physically present is unavailable. [18] The applications stem from simulation software to educational experiences, to even virtual classrooms. The possibility of VR can be explored even further in an educational setting.

2.1 Research Questions

- Research Question #1: How well does Virtual Reality act as a medium for presenting information to learners in regard to information retention?
- Research Question #2: What features should be kept in mind when developing a Virtual Reality experience to reduce the cognitive load?

- Research Question #3: How does Virtual Reality benefit people who identify as kinesthetic learners? Do learning preferences align with Virtual Reality, PowerPoint Presentation, and Written Article forms of presentation?
- Research Question #4: Do people believe that Virtual Reality can aid a learner in retaining information?
- Research Question #5: Do people think that Virtual Reality is a beneficial form of learning?
- Research Question #6: Does Virtual Reality improve learners' enjoyment of the learning experience?

3 METHODOLOGY

3.1 Participants

Our experiment used 34 participants who were available for participation. All participants willingly volunteered for the experiment and described their level of understanding in regard to the topic. Most participants expressed having surface-level to introductory knowledge of the topic. All participants were between the age group of 20-60 and had varying backgrounds. Most participants were college students with some being middle-aged parents and siblings. The general education level of participants was that of a college graduate or college attendee.

3.2 Apparatus

With our experiment having a variety of mediums there were very different experiences and software needed depending on the group a participant was in. Most of the groups would only need a computer to which they could read the essay or watch the PowerPoint on Van Gogh's paintings. This would mean each computer would need to have the capability of using Microsoft PowerPoint if they were in the presentation. As our group is mainly about comparing these two other groups learning to learning with VR, one group would have to be able to use VR systems. For the VR group, we made our own custom VR experience that takes the user through Van Gogh's paintings while giving necessary information to them through voice-overs and interactives in the VR experience. Our main VR system used for the experiment was the Valve Index.

3.3 Procedure

For the procedure of our experiment, we would try to keep every group as close to the other as possible. The only varying difference was the variation in how the information was presented to each group. To start we gave the participants their information medium on Van Gogh as well as a short tutorial if given the VR experience. The main task description given to each participant before testing was to try and retain as much knowledge as possible of what was about to be shown to them. When their testing concluded we then gave them a survey that asked questions to get some background knowledge on their previous knowledge, perception of their medium as a form of learning, how well they felt their medium aided in information retention, what can be done to improve their medium of learning, as well as their experience with their medium. The questions were all qualitative to provide a deeper understanding of the participants as well as how they felt about their learning process with their given medium. The survey before testing asked about many things, including how well they would rate their previous knowledge of their information medium, as well as any previous knowledge they had on Van Gogh beforehand. Within this survey, we also had a brief quiz, regarding the information provided. The questions were mainly about Van Gogh's paintings they were shown as well as information about Van Gogh himself. During the exam, participants were also allowed to take short 2-5 minute breaks to clear their heads or get rid of some fatigue that might be caused by the individual learning methods. Once the end survey was taken they were free to go as they were officially done with their part of the experiment. One final detail we noted from

each participant was their actual score on the exam as we used this data to point out trends in each medium's learning as well as help us to point out any mistake in procedure we might have made with each medium.

3.4 Design

The experiment was a between-subjects qualitative design. We had 34 different participants each put in groups of 10-12 making 3 groups, each with a different learning method. Our Independent Variable for this experiment was the learning medium in which the information would be given about Van Gogh. The Dependent Variable was how well each individual felt they learned the information given to them based on their feelings about the test. There are also some Random Variables which were each participant's previous knowledge of Van Gogh as well as their previous interactions/experiences with VR. Our main Control variable was the base information being presented to the participants no matter what medium it was put in. Overall, we had a total of 34 trials (34 participants x 1 learning method x 1 session x 1 trial per session).

4 RESULTS

The results of the experiment provide insightful data on the effectiveness of different learning mediums in conveying information. Within this section, we will present the findings related to how each medium impacted participants' learning outcomes, engagement levels, and overall satisfaction with the educational experience.

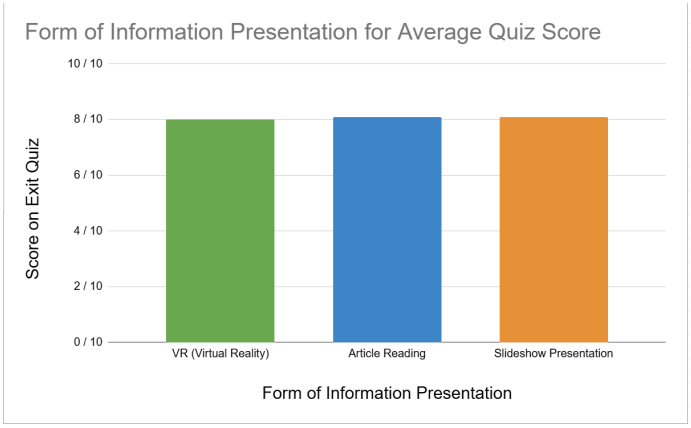

Fig. 1. Form of Information Presented by Average Quiz Score

The results of Figure 1 indicate that each learning medium produced very similar results when it came to the average quiz score. The participants answered 10 questions that were to gauge their information retention and understanding on the information presented. As seen in Figure 1, across all learning mediums the average score was a 8 out of 10. A good portion of the participants' scores were in the 6 to 9 range, at around 58.8% (20/34) of all participants, while 32.3% (11/34) participants got all 10 questions correct. On the opposite side of the scoring average, there were a few participants that were outliers, one participant scored a 5 out of 10 accounting for 2.9% of our participants, one participant scored a 4 out of 10 accounting for 2.9% as well, and finally, we had a participant that scored a 3 out of 10 on the quiz, again accounting for 2.9% of our participants.

The participant who got a 3 out of 10 was a part of the article reading group and stated that they had a neutral feeling about the learning medium provided. The participant expressed displeasure when it came to reading the article due to the "amount of words", along with describing how they think it could be improved with "pictures or videos". The participant who scored a 4 out of 10 was a part of the slideshow presentation group and didn't show any displeasure with the slideshow, but instead stated that they "like slideshows because they have pictures and not just boring words". The participant that scored a 5 out of 10 was a part of the article reading group and stated that it "reminded them of high school", which was a "disliked experience". All of these participants shared that they prefer a visual medium over a non-visual medium to learn from.

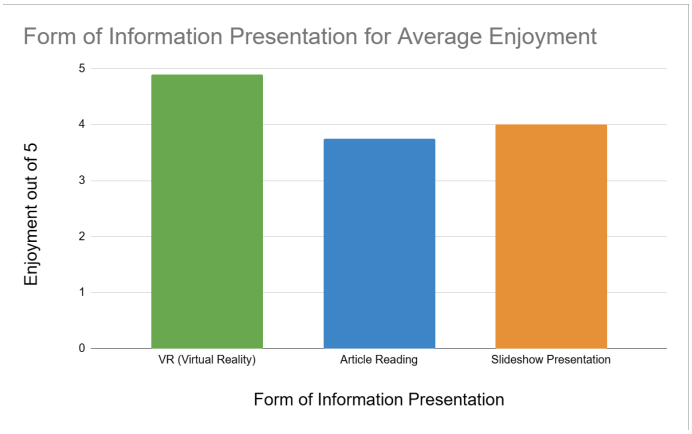

Fig. 2. Form of Information Presented by Average Enjoyment

The results shown in Figure 2 were collected after all participants had finished their experience. The participants answered on a Likert scale of 1-5 to express their enjoyment of their learning experience. As seen in Figure 2 on average participants who participated in the VR experience found it the most enjoyable with an average score of 4.9. The slideshow presentation follows behind with an average score of 4. Finally, article reading had an average score of 3.75. Most answers for all groups trended positive with 50% (17/34) of the participants selecting 5, 26.5% (9/34) selecting 4, and 17.6% (6/34) selecting 3. We had 1 participant select 2 and 1 participant select 1 each accounting for 2.9% of our participants.

The participant who selected 1 was in the article reading group and still performed very well scoring all 10 points available. The participant expressed distaste and boredom with reading the article, describing it as a "dated" technique of learning. The participant who selected 2 was also in the article reading group. They scored 5 out of 10 available points and similarly expressed distaste for the experience. They explained that it "Reminded them of high school" and that they "disliked the experience". When asked what helps them learn, both of the best participants expressed that audio is helpful for learning.

When asked to describe their opinion about the form of information presented to them we had a wide variety of responses. Around 44% (15/34) of participants expressed that some form of kinesthetic learning or a combination of kinesthetic and more traditional learning was most helpful for them when learning about new topics. One participant described that having time to practice and interact with the knowledge he had recently learned allowed him to remember it better. Another participant expressed that being walked through a process and being hands-on allowed her to learn

the best. She expressed that the Virtual Reality experience is similar to what she looks for in an educative experience. Multiple participants used the words physical or hands-on when describing their preferred learning style.

All participants who were in the VR group expressed interest in VR as a form of education. Many of the participants even presented ideas of how it could be used. One participant expressed "I can see this form of presentation being used in museums and classes". Another said "This form of learning could be invaluable. It involves us to use our senses, and using our spatial surroundings can help others pay attention who might have a hard time sitting still". The reception was extremely positive and many participants expressed interest in having similar learning experiences in the future.

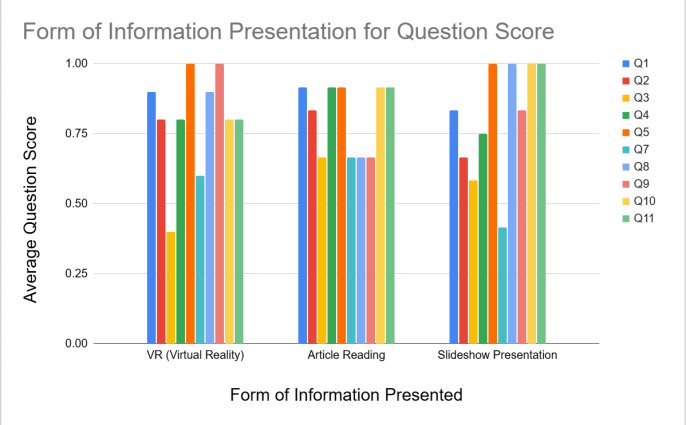

Fig. 3. Form of Information Presented by Individual Question Score

The results shown in Figure 3 show the average individual quiz questions by presentation group. Question 6 was an ungraded question in the final count. We can see some trends in how well the groups scored by question. For example, the VR group seemed to have issues with question #3 with only 40% correctly answering. The slideshow presentation group had issues with question #7 with roughly 42% of participants answering correctly. From Figure 3 we can see that the article-reading group seemed to have the most consistent success when answering questions with none of them falling below 66% for correctly answering, but never reaching 100% success for any question within the group. The slideshow presentation and the VR groups were less consistent with results ranging from roughly 40% correct to 100% correct depending on the question.

5 DISCUSSION

Many things can be deciphered from looking through our results, as we attempt to look at meaningful deductions and trends that were set by our participants and their data. The main question to be answered from our data is whether or not VR can be an accredited information method as compared to our control groups of the article and presentation learning methods. As we discussed in Figure 1 above the data can be seen as similar if we just look at the average scores per medium which were all about 8 correct answers. When looking at the variety in Figure 3 we can see average scores for the individual questions we gave to each medium. Between the three mediums, the article is the most consistent but still has lower averages for some questions than the VR or presentation medium. On the other hand the VR had some of the highest averages and lowest averages from question to question really demonstrating its effectiveness at portraying

some types of information as compared to others. Even though all three mediums had around the same average it was interesting to see the drastic ways in which each medium got there.

Pulling from this statement we can make a lot of deductions on how well each medium is actually doing at keeping retention and some of the reasons behind this. the main culprit of the VR medium is most likely how memorable it can be from the beginning to the end. It is skewed to be more dramatic or relatable from person to person and scene to scene as with all games in history. The beginning and ends of most games are where we are most susceptible to information as we are entering and exiting the state of being engaged. as such the questions that require information from the middle might suffer depending on how relatable they are or how much influence they have on the overall narrative of the game/experience. This will not affect the article, however, as its is the same experience throughout. While reading an article we are experiencing the same stimuli throughout as when playing the game our stimuli is going from low to high constantly depending on our interactions. While it may not be everything, the overall interaction and experience of a medium could play a huge part into how consistent your information retention might be, but not into how effective it will be.

One main distinction that was found in our experiment was the overall difference in enjoyment that our participants found in their given information medium. While the article got more even scores its overall enjoyment was the lowest among the three at around 3.6 (figure 2). The presentation wasn't too far ahead with an overall score of around 4.0, but VR , however, had an extremely high score of almost a perfect 5/5 with just one person giving it less than a five. This is highly irregular as even though the two lowest scorers were in VR and presentation, these mediums still got a better overall enjoyment than the article, with the lowest person still giving VR a max score. When looking at the information given to us from our experiment we can see that while enjoyment might not end up getting your better information retention it might influence how willing you are to learn this data. If you are more willing to learn the data or you are enjoying your experience more, then you could possibly end up delving further into a topic than originally needed, so even though enjoyment doesn't have an outright involvement in your overall retention you could end up more passionate about the subject you are engaging in.

One form that could affect this enjoyment that we saw is in how best people learn. Many of our participants stated that they are hands-on learners or kinesthetic learners. Based on our three information mediums the most hands on is the VR medium in question. When given some way to interact with their information or visually hear the information being given to them, some people are given a more concrete experience in the retention of that said data. This type of medium isn't for everyone which can also be used to explain the more sporadic scores in VR and presentation. While the article might be the more familiar way of retention that most people have likely experienced, this does not mean that it is the most efficient method for everyone. The article's close answers are most likely due to what we just discussed in how long everyone has been forced to learn through this medium in school.

Overall, there were a majority of people that when asked their best ways of learning had some form of interaction or practice problems in their answer. Many people seem to benefit from this type of medium which is the main reason why this study was conducted. With VR being a relatively new medium to interact and learn with, it is in everyone's best interest to fully utilize and test its capabilities, and while it wasn't an outright winner when compared to the more formal mediums, paired with someone who is exclusively a kinesthetic learner, the results can be astounding.

6 CONCLUSION

In our study, we presented compelling evidence of the diverse impacts of digital storytelling methods on learning outcomes, with a focus on information retention. The experiment utilized a comparative approach, engaging participants

with educational content about Vincent Van Gogh through three methods: A traditional reading article, a PowerPoint slideshow, and a Virtual Reality experience. The results of the experiments suggest that while all mediums were effective to some extent, the VR experience notably enhanced engagement and enjoyment, potentially leading to higher information retention. Participants in the VR group reported a higher average enjoyment score and demonstrated a stronger preference for the immersive and interactive nature of VR. While the study indicates that the Virtual Reality experience led to a higher enjoyment, it didn't necessarily result in better knowledge retention compared to the traditional and slideshow methods. All subjects produced similar average quiz scores. This highlights that while VR can enhance the learning experience through greater engagement and enjoyment, it doesn't automatically translate to superior retention of information. This finding suggests that while VR is a promising tool for making learning experiences more enjoyable and immersive, its effectiveness in enhancing information retention might depend on various factors, such as the nature of the content, the design of the VR experience, and individual differences in how people learn. Therefore, further research could explore how VR can be optimized or combined with other educational strategies to not only increase enjoyment but also effectively boost learning outcomes.

6.1 Future Work

Our study focuses on the reception of learners to Virtual Reality and their overall performance when retaining information from their experience. Virtual Reality and education can be explored in a multitude of ways. As people become more open to the idea of utilizing Virtual Reality in education we believe it will see more use, particularly in simulation or example settings that give learners an approximation of real-world scenarios. To achieve more integration future work needs to focus on the efficacy of virtual reality as a way of delivering information. We believe that more work can be done that focuses on the interaction of hands-on workers or kinesthetic learners with Virtutal Reality as a medium for their learning. Another aspect to explore is the use of virtual reality as a baseline of information for learners. Exploring the interaction between using virtual reality to introduce information and build a baseline for people to understand and learn from with future success in learning adjacent or advanced topics in the same field would be interesting to see. Our study serves to show that many people find a VR experience as a valuable learning avenue and that they were able to achieve similar results as other mediums when learning new content.

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