# Analysis of Current Virtual Reality Methods to Enhance Learning in Education

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## Abstract

Virtual Reality is integrating itself into education with the benefits of being an interactive technology that can redefine the way and the what users (Students and Teachers) can see, learn and interact with. This paper critically evaluates current research into Virtual reality as a medium for education to aid teaching using both mobile based and desktop-based headsets as learning devices and evaluates their uses and testing methodologies to understand how their methods can be used in other areas of education. Methods used by other researchers will be compared against one another to provide conclusions and recommendations based upon the evaluation of their methods. The paper will conclude with recommendations of where the technology could impact an area of education for implementing the technology and gaps of knowledge in the field.

## 1 Introduction

Teaching methods haven't drastically changed over the last few years and with the different learning styles that students can have it's important to find the best methods for their learning. Virtual Reality learning would as stated by Minocha et. al. (2018) "foster creativity and inquiry" this would provide students a method that would inspire them to think creatively as well as let them get used to future technologies. Virtual reality is perceived as a gaming system by many however these games can be educational as research by Jin, G et.al (2018) showed with an educational game designed to teach high school students cyber security using virtual reality the results were highly positive based off result surveys.

Problems can occur when introducing Virtual Reality as not all students will be able to participate within Virtual Reality lessons due to potential health risks such as Seizures for epileptics or eye pains for those with bad eye sight, A large area of space is also required for some methods of Virtual Reality such as the HTC Vive and Oculus Rift. In order for effective use Vesisenaho and Juntunen et.al (2019)believe that "To promote active learning in VR, students should have the ability to interact with relevant content (e.g., seek information, ask questions)."

There are different applications of virtual reality that can be applied to education such as a mobile based approach which some focus on using with applications like Google Expeditions to show students areas of the world.

Researcher Pulijaala (2018) researches into Virtual Reality on the training of professionals such as surgeons by using an oculus rift environment to conclude if the Virtual Reality is effective for the learners, concluding that the self-confidence of performing surgeries for the control group were higher. Other methods have designed fully interactive scenarios that the learners will go through in order to learn such as Zhang et.al. (2017) that devised a new method to change fire safety education which "the experiment results prove the feasibility and effectiveness of the proposed approach".

The Virtual Reality Headsets described are computer based however there are also mobile based Virtual reality systems that are cheaper than the computer based headsets however they do require students to own a mobile device.

This Research paper will analyse experiments that have been conducted on Virtual Reality in Education with the aim of comparing different researchers' methods through Mobile based and desktop based

Virtual Reality and if their methods could improve one another.

## 2 Analysis on Virtual Reality versus Traditional Learning Methods

As there are different Methodologies to Virtual Reality such as mobile based and none mobile based ones such as the HTC Vive. These sections will be split into 2.1 and 2.2.

### 2.1 Mobile Based Virtual Reality Learning Methods

Yoganathan Et.Al (2018) researched into looking at using 360° Virtual Reality video as an application for teaching reef knot tying in surgical education as opposed to a 2D video teaching method. The main aim of this research was to identify mobile VR as an option for education, Mobile VR is becoming more affordable as Yoganathan Et.Al (2018) mentions "The cost of a headset is variable, however it can cost as little as £1.50 for the most basic product."

Forty foundation year doctors were randomized using a computerized random number generator with twenty being placed in two groups, one group would use a video to watch from a laptop screen and the other group to use the 360-degree VR video, both groups were given twenty minutes, fifteen to watch the videos and another five for independent practice. (Yoganathan Et.Al 2018)

To test the participants they were assessed by an assessor on their ability to tie a reef knot, there was no time limit for this and assessment ended when a reef knot was performed or the participant declared they were unable. The assessor was also unaware of which group the participant was a part of. Two types of results were measured one that graded the knot and the other on time taken to complete the knot. (Yoganathan Et.Al 2018)

| Median knot tying score (range) maximum = 13 | | | |
|---|---|---|---|
| | Standard video n = 20 | Virtual reality video n = 20 | p-value |
| Post video alone | 4 (2–9) | 5 (2–9) | 0.0396 |
| Post video + face to face teaching | 9 (2–13) | 9.5 (6–13) | 0.0141 |
| **Median time taken to construct a complete single handed reef knot in seconds (range)** | | | |
| | Standard video n = 12 | Virtual reality video n = 17 | p-value |
| Post video + face to face teaching | 30.50 (22–41) | 31.00 (19–44) | 0.8942 |

**Figure 14 Knot tying scores and time taken (Yoganathan Et.Al 2018)**

Results showed that knot scores were marginally better in the VR group compared to the standard video group aswell as that a larger amount of participants were able to tie a knot with twelve being able to in the Video group and seventeen in the VR group.

The research concludes that the VR can be used as a standalone video that can teach students aswell as supplement current teaching methods to further learning. Other areas of surgical training could benefit from the acquisition of a VR based method to teach skills. The researchers mention that a further study could be conducted to see if the skills have been memorable by conducting a follow up with the participants to see if they can still tie a reef knot.

| | | Standard (n = 20) | Virtual reality (n = 20) |
|---|---|---|---|
| Sex | Male | 14 | 12 |
| | Female | 6 | 8 |
| Dominant Hand | Right | 17 | 18 |
| | Left | 3 | 2 |
| Career level | Foundation Year 1 | 14 | 15 |
| | Foundation Year 2 | 6 | 5 |
| Previous attendance on surgical skills course | No | 17 | 18 |
| | Yes | 3 | 2 |
| Previous knot tying exposure | No prior | 7 | 8 |
| | Observed | 7 | 7 |
| | Performed in simulated setting | 3 | 2 |
| | Performed in clinical setting under supervision | 3 | 3 |
| | Performed in clinical setting independently | 0 | 0 |
| Surgical career aspiration | No | 6 | 6 |
| | Yes | 8 | 9 |
| | Undecided | 6 | 5 |

**Figure 2 Participant Grouping(Yoganathan Et.Al 2018)**

The Groups were split evenly and randomly to eliminate bias from the results aswell as the individual assessor that also didn't know what group the participant was from when assessing their knots. The sample size of forty is a reasonable size as for their experiement it gives quantative data allowing an easy comparison between the effectiveness of the methods used and used methods that seek to eliminate any bias aswell as giving clear information on how the experiment was done if it was to be repeated. The data in the study shows validity with the researchers Yoganathan Et.Al (2018) providing justified and valid research.

Another Method of Mobile VR is use of Google Cardboard which Researchers Chin Et.Al(2017) used to create a simulation of a water cycle to use for teaching the water cycle. The Researchers had looked at learning types of students finding that "According to a study done at the University Of Alabama School Of Medicine, the majority of people are visual learners, meaning they learn best when looking at a visual representation of a concept."(Chin Et.Al 2017) the aim of this research is to create an immersive visual experience for learners.

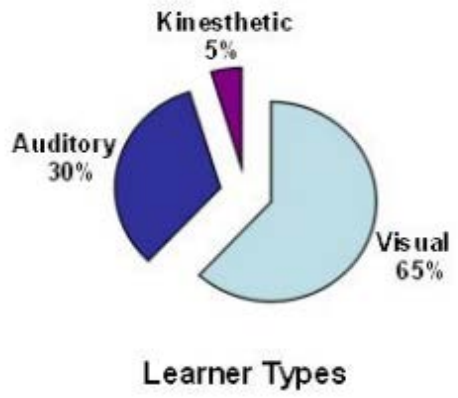


**Figure 3 Learner Types (Chin Et.Al 2017)**

For this research the researchers programmed what they called SplashSim in unity designed to work for the Google cardboard which is an inexpensive approach for Virtual Reality.

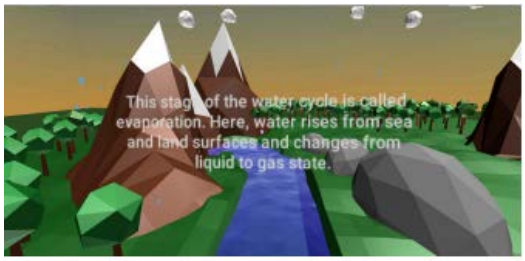


**Figure 4 SplashSim (Chin Et.Al 2017)**

This research goes into depth on the process of creating the software however it doesn't mention how it was tested or if tests were done, ideas of how the technology can be taken forward mentions using it to show lab experiments but with a lack of evidence showing any improvement on student learning further research would need to be done. There is no methodology on how the experiments were done therefore these conclusions are not justified.

Lucas (2018) researched a method of using a headset based VR in Construction education similar to Chin Et.Al(2017) they created a simulation of a house mid development this was to allow students to see a house during development which can be beneficial for their studies.

Before the experiments participants were surveyed for experience on Virtual Reality as well as a survey quizzing them on understanding of wood frame construction, After completing the first survey, participants received a description of how to navigate through the environment and what to expect while in the environment.

A total of approximately 110 students were enrolled in the three classes (some students in more than one of the classes). Those who were highly prone to motion sickness or had any issues with cyber-sickness during any prior VR-type experience were asked to not participate. Otherwise, there was no criteria besides being a student in the program to take part in the study.
They then took 5-8 minutes to explore the environment. Participants were also quizzed after to ask about the simulations influence on their understanding now. Usability was also surveyed. (Lucas 2018)

The research concluded that user navigation and wayfinding was easy for the participants with controller based navigation being a familiar concept to the participants. The researcher wanted to figure out how this method compared with traditional education materials which they showed the participants in the first survey and gather data from. The research concluded that the participants had a 64% improved understanding with Virtual Reality.

This research used 110 participants during its experiments which is a good size it gathered good qualitative data by using surveys, However the research does its experiments in a order which affects the results by first showing the participants traditional learning methods of wood frame construction and asking their understanding and then making them use the Virtual Reality simulation as they will get an improved understanding simply because they're getting a second time learning about wood frame construction therefore the results are biased making them invalid.

## 2.2 Computer based Virtual Reality Learning Methods

Bogusevschi Et. Al. (2018) took to computer based Virtual reality to provide primary school children with an immersive experience in a nature application. For this research they used 58 primary school children and split them into two groups a control group and an experimental group.

| *Activity* | *Control Group* | *Experimental Group* |
|---|---|---|
| Knowledge Pre-test | ✓ | ✓ |
| Classic Approach (power point presentation) | ✓ | - |
| NEWTON project Approach (*Water Cycle in Nature* application) | - | ✓ |
| Learner Satisfaction Questionnaire | - | ✓ |
| Knowledge Post-test | ✓ | ✓ |
| NEWTON project Approach (*Water Cycle in Nature* application) | ✓ | - |
| Learner Satisfaction questionnaire | ✓ | - |

**Figure 5 Grouping Activities (Bogusevschi Et.Al 2017)**

One group would focus on knowledge gained for the participants and a second one for the usability and learner experience. The control group were taught via a PowerPoint presentation  The second part of the case study, and the focus of this paper, was on application usability and learner experience, and were assessed using a Learner Satisfaction Questionnaire. (Bogusevschi Et. Al. 2018)

The research found that 67% of the children though the application had helped their understanding of topics such like vaporization and condensation. There was a high 94.83% of children that said that they would like to have more lessons similar to the Water Cycle in Nature application, however 24% found the VR to be distracting from their learning.

The Researchers don't mention any means to eliminate any bias as there is no randomization of the groups. Overall the research does find a basis that Computer based Virtual reality applications can have a good effect on student learning and get them to engage with one another.

Another form of education that has been researched for use with a Virtual Reality Headset is the teaching of teachers by researchers Lugrin Et.Al.(2018) with the main aim being to bridge theories and practices by bringing them to life with immersive virtual reality.

The seminars were split into two one with the VR assist which is done with an instructor being able to trigger events in a classroom that the trainee teacher would have to deal with. The other group would have a video-assisted seminar.


**Figure 6 VR views (Lugrin Et.Al 2018)**

A pre seminar test was taken at the start of the experimentation to see what level the participants were at and what they scored would be compared with what they score at the end of the experiment to check for improvements.

There were a total of 54 participants taken part in this research which is a good number of participants. There were two groups  Group 1 consisted of 36 and was working with the virtual reality and group 2 consisted of 18 working with traditional videos. Ideally the groups should be the same size to get a fair comparison between the two of the groups.

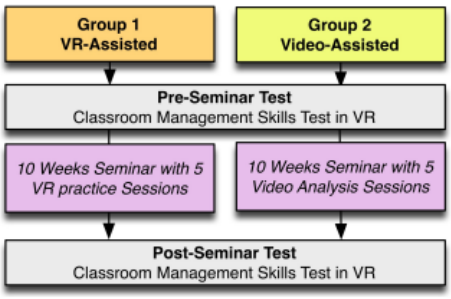


Figure 3: Experiment Design Overview

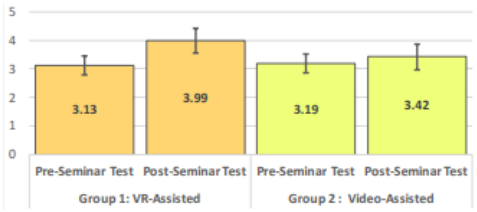


**Figure 7 Seminar Results (Lugrin Et.Al 2018)**

The research finds that the group with VR-Assisted methods scored higher on the post-seminar test while scoring lower on the pre seminar test. In conclusion the research shows a benefit can be gained from VR-assisted education.

This research shows good and comparative data with the tests the students took however the imbalance on group numbers makes the research questionable and can skew the conclusions that they have come to. Even with the number imbalance the results do look promising with the group VR group having more participants in as well as scoring higher on average than the group with less.

Parong and Mayer (2018) used a VR simulation of a human body the virtual reality will take the player around the body on a tour of blood streams. They created two experiments, the first experiment is based on the learners interest and self-efficiency of 55 participants. The second experiment planned to see if adding prompts in the Virtual reality lesson increases the learning outcomes of 57 participants. Experiment 1 split the participants up and group 1 had a slideshow lesson and group 2 with the VR with post lesson questionnaires to gather results.

Experiment 2 got participants to write summaries after a segment on what they had just seen the rest would use the virtual reality without summarizing between segments.

The results showed that the slideshow was more efficient at conveying scientific information when compared to the virtual reality however the participants found the virtual reality to be far more enjoyable. This resulted in the research providing evidence that it isn't worth the investment of converting basic scientific knowledge to a virtual reality environment.

The results were easy to understand in the form of a questionnaire and results from a small test show which experiment gave a better understanding. It shows that virtual reality can be beneficial as it is enjoyed by participants however more research is needed to make them more educational which is a similar finding to what Pinto and Peixoto et.al (2019)"results revealed that while presence and satisfaction were higher in Virtual Reality, the knowledge retention score remains the same". This research had a good experiment in place to gets reliable and justified data.

## 3 Comparisons of Mobile and Computer based Virtual Reality Learning methods

Computer and Mobile based Virtual Reality methods show good merits to providing an improved means of education. The main Comparisons seem to be that computer based immersive experiences seem to have more practical use within higher educational practices. Whereas the mobile Virtual Reality seems to shine at teaching younger audiences this could be due to the beneficial nature of just being able to see what is happening makes it easier to pick up simpler concepts. Although Yoganathan Et.Al (2018) takes mobile based into foundation level and gets good results from their experiment

Chin Et.Al(2017) and Bogusevschi Et. Al. (2018) both taught the same subjects using two different methods with Chin Et.Al(2017) method the students would simply observe the water cycle whereas Bogusevschi Et. Al. (2018) allowed for interaction. Bogusevschi Et. Al. (2018) didn't get comparative data from his experiment and didn't test the participants to check if there was any knowledge improvement after their sessions however his participants did enjoy and find the session helpful.

Using Chin Et.Al(2018) mobile method of having participants spectate and have knowledge given to them almost movie like would have been a good model to use for Parong and Mayer (2018) experiments as it would be useful to implement scientific methods for the human body.

## 4 Conclusions

A lot of the research done in this field wasn't particularly done in the highest level with some researchers not mentioning and limiting potential bias in their experiments, However the research that has been done and has accurate results show that a use of virtual reality could definitely be in education.

The main concern for Virtual Reality in education is the need for a Virtual Reality device which students won't all have access to and on top of that schools would have to pay a lot for to provide for their students. Another concern which can be highlighted in Virtual Reality is the risk of cyber sickness which with prolonged use would cause health risks.

The research in this field is trying to find the balance between what can and can't be taught with virtual reality with the simpler the subject/skill to teach the better it is to educate across with Virtual Reality such as with Yoganathan Et.Al (2018) research. Mobile based virtual reality is simpler by nature making it a lot easier for users to use as well as to get learning materials onto therefore can make great supplements when it comes to a lesson instead of being whole based.

Desktop VR is still an early concept to push into education with a lot of development still needed to make experiences more educational as well as more immersive. Subjects such as IT could benefit greatly from virtual reality systems to help its students as well as save costs, Computer building can be tricky to teach in colleges and using VR could be the answer with a software developed to show the ins and outs of computers for Computer Hardware Engineering students.

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