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Virtual Reality's Impacts on Learning Results in 5.0 Education : a Meta-Analysis

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Abstract

In recent years, the use of virtual reality (VR) in the classroom has grown in popularity. New learning possibilities are made possible by its presence and immersive design. Due to this expansion, several research have been done to determine how VR affects learning results. Meta-analyses that condense the impacts of VR on learning acquisition are now necessary due to the growth of experimental investigations. However, there are a number of evaluations in the present literature that concentrate on 5.0 students and examine the impact of a number of factors, including immersion level, length of intervention, and subject matter. However, there are a number of evaluations in the present literature that concentrate on 5.0 students and examine the impact of a number of factors, including immersion level, length of intervention, and subject matter. To fulfill this demand, this meta-analysis was conducted. Eight experimental papers were eventually included in the meta-analysis following a pre-selection of 286 references published between 2010 and 2021this . The findings demonstrate that, generally speaking, VR fosters greater student learning than the control conditionApart from that, the effect is considerably more pronounced with immersive VR than with semi-immersive and non-immersive systems. This effect is independent of the level of education in which VR is used and most areas of knowledge. Additionally, shorter treatments are less successful than longer ones.

Keywords: Virtual Reality, 5.0 Education, Meta-Analysis.

1. Introduction

the previous years, virtual reality (VR) has evolved increasingly important in education. One of the Edutrends reports on era 5.0. [1]and the Observatorio de Innovación Educativa del Tecnológico de Monterrey (2017) is the technology trend that has had the greatest impact on VR in the context of short and mid-term education. Particularly in the next two to five years, we view it as a phase. The EDUCAUSE Horizon Report 2020 [2] says that the use of VR continues to expand as individuals utilize it owing to a number of causes rising. His accessibility;

sustainable cost savings combined with advances in electronic device performance. Better experience with wireless and cellular networks and more experience realism.

1.1 Virtual Reality

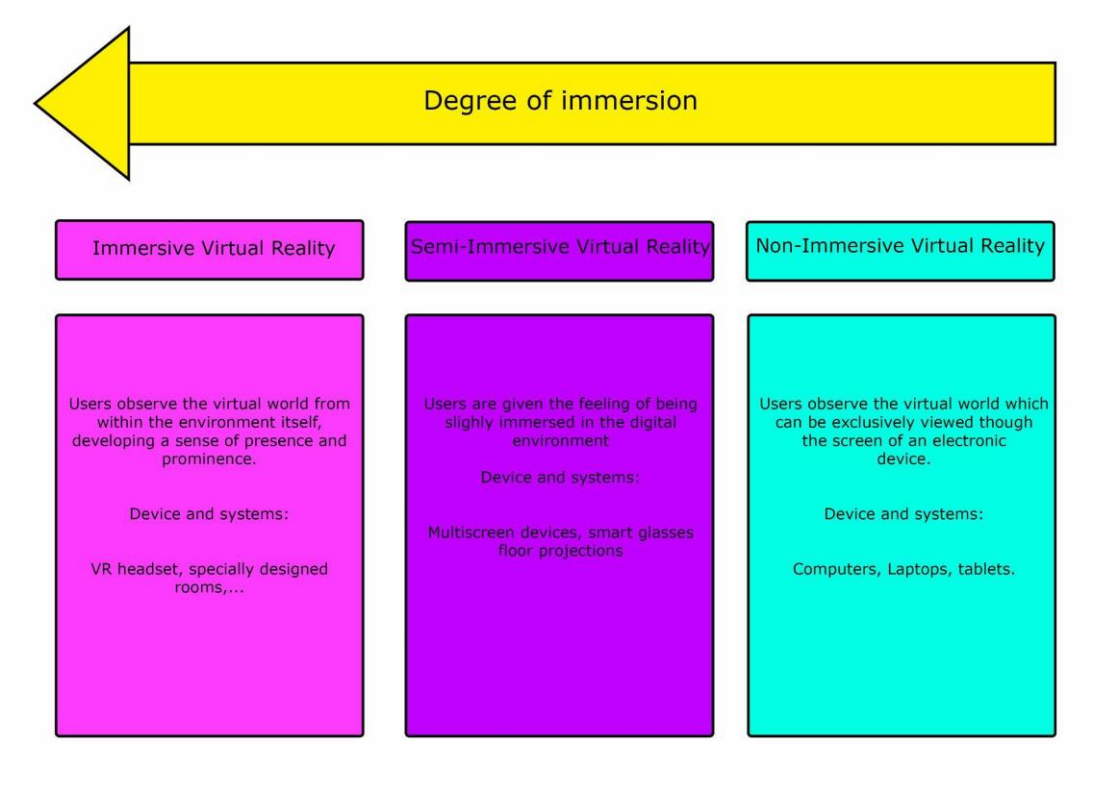
With the use of computer visual simulations that let users immerse themselves in an interactive 3D world where many sorts of sensory and emotional experiences often take place, VR is a technology that generates a virtual immersive sensation in a digital environment.. Today, VR technology is spreading to various disciplines and sectors as technology advances [2]For example, VR is surgical education [3], sports training, language learning, heritage education [8], and even treatments to treat stage phobia. Meta-analyses are now open to the public, particularly in surgical training , the practice of certain medical procedures, and VR in certain medical treatments. condition Indicates the usefulness of. Fear and the like and their emergence in certain situations, such as the treatment of fear of flying [4].

The key factors driving VR's popularity in education are its immersive, inventive, and participatory elements. [5]. Blascovich et al.(2002) draw attention to the fact that its use enables students to be put in an alternative world with realism that could never be accomplished with textbooks while avoiding, at the same time, some features that might impede learning. Due to its application in teaching, students may immerse themselves in a variety of environments and eras[6]. This technology, according to Cuesta and Manas (2016), is a tool that can overcome the spacetime constraints of the educational setting to provide experiential learning. Regarding VR, two ideas might be regarded as essential: involvement and presence. Although they are frequently used synonymously, the term "immersion" refers to the experience of utilizing so-called immersive technology. while presence describes the user's subjective reaction to a VR experience in a way that is comparable to what would happen in a certain setting. identical in real life. It is emphasized by several authors that this immersion is a special quality that sets it apart from other computer programs. There isn't just one kind of VR, though. As seen in Figure 1, As a result, the characteristics of VR technology dictate how immersive the user experience will be[7].

The most immersive systems are those that use virtual reality (VR) immersion. This technology allows for egocentric navigation, where the user views the virtual environment from within the actual environment, as the scene is updated regularly by head or body movements, they get a sensation of presence and prominence and strengthen their sense of realism[8]. As the scene is updated on a frequent basis by head or body movements, the audience feels more prominent and present, which heightens the impression of realism. This is accomplished by either enhancing the user's active engagement with the virtual world or amplifying some sensory input. Finally, Users engage in a virtual environment that is created and only seen through an electronic device's screen in non-immersive VR systems, often a laptop or computer. A desktop VR system or 3D world is another name for it. The keyboard and mouse are mostly used at this level to carry out the control mechanism. [9].

1.2 Literature Review

In recent years, there has been increasing interest in education and research for the effective use of VR. However, there is a paucity of research aimed at exploring the potential and classroom application strategies of this technology for elementary school students [10].It is important to understand the impact on academic performance and attitudes, as children are expected to use more technology . However, most were published before the quality of these technologies increased and costs were reduced [25], which may limit the validity of the results obtained in the study. On the other hand, there are more systematic reviews. The qualitative analysis provided in this literature review is crucial for developing educational research. but with the drawback of not offering a numerical metric that enables a comparison of VR's effects on education. The use of meta-analysis has therefore been suggested as an alternative to the widely utilized quantitative methodologies, as numerous scholars have noted [11].



Picture 1. Conceptual diagram of the difference in VR system according to the degree of immersion

One of the meta-analyses completed so far included 19 research with participants ranging in age from kindergarten to higher education, but the analysis did not determine whether student age or educational level ultimately made a difference. These findings generally show that utilizing virtual simulations for learning has a good effect, but that students' views against using VR have a negative effect[12]. studied the impacts of VR instruction on students in K–12 as well as those in higher education, however their analysis was restricted to non–immersive VR systems, which they divided into three subcategories: games, virtual worlds and simulations. Only eight publications from basic research investigations were included in this meta-analysis. We contrasted the 5.0 pupils' performance as a head-mounted display with those of other VR technologies. According to their findings, the head-mounted display outperforms competing systems with lower effect sizes. However, 28 of the 35 research that made up this meta-analysis were carried out in junior secondary schools, highlighting how few investigations were done in elementary schools in this analysis [13].

A number of systematic evaluations have also emphasized the expanding significance of VR in the context of education. 3D virtual multi-user settings were the topic of reviews by authors including Mantziou, Papachristos, and Mikropoulos in 2018. A systematic review of 21 studies published between 2013 and 2017 is done by Jensen and Konradsen (2018). research using numbers[15]. In terms of educational results, They examined the IVR system's educational usage but did not concentrate on a particular target audience. Snelson and Hsu's (2020) research centered on weighing the benefits and drawbacks of employing 360-degree video.. Similar to how there haven't been many evaluations of VR and serious games for training and education, we took a strategy that concentrated on the knowledge domain. There are research on IVR that concentrate largely on higher education and offer recommendations for enhancing academic performance and motivation. equivalent to Squeeze and co. (2021) We examine the relationship between non-immersive VR, motivation, and learning outcomes. Di Natale and co. are the last (2020) IVR use has been linked to improved academic performance and increased

enthusiasm to study, according to a total of 18 publications. and that the capacity to move about and engage in this immersive environment might help people absorb learning materials better. However, polls on non-immersive and semi-immersive VR systems are not included in this study[14].

The advantages of VR in this field are demonstrated in this systematic review, which yields some crucial conclusions for the academic community.However, in part, this task covers questions that the present meta-analysis does not answer include: B. A comparison of the VR intervention's results based on the date of publishing or the degree of education involved. So far there is no VR effect comparison system available based on the level of VR technological sophistication or the pertinent knowledge topic. Some of these unsolved problems are addressed in the present meta-analysis, which focuses on research done in kindergartens and primary schools.[15].

1.3 Purpose of the study

This study advances the area of virtual reality by addressing some of the shortcomings of earlier reviews and meta-analyses. The primary goal of this meta-analysis was to assess the impact of VR technology in education 5.0 on students' academic performance[16]. This study intends to learn more about which aspects of virtual reality have a significant influence on the learning process in certain circumstances, beyond gaining a broad grasp of the usefulness of this technology. As a result, a number of moderator factors, including immersion level, subjects, academic level, and project duration, were included in the study. The degree to which VR technology can effectively replace the sense of the actual world with the virtual world is determined by immersive, which is more immersive than the system in the earlier context. As a consequence, students do better academically and have more opportunities. Second, prior research looked at whether factors like user age, learning domain, and length of intervention may moderate the impacts of VR technology [17]. Wu et al. (2020) found significant variations between K–12 and post–higher education students in the effectiveness of IVR systems with head-mounted displays for learning performance. According to the author, the development of different information and skills that might impact the efficacy of virtual reality is connected to each degree of education. In this analysis, we evaluated potential variations brought on by 5.0 education level grades, which have received little prior research. Thirdly, while VR is a technology that is now applied in a variety of fields, the degree of its development does not seem to be uniform. Wu et alstatistical .'s data that were provided. (2020), the impact of VR may be influenced by the kind of material that is made available through these systems. In our research,we used subjects as moderating variables to determine whether the impact of VR on student performance was uniform across domains, or, conversely, whether some subjects were better suited to using VR. I will clarify. Finally, regarding the relationship between VR use and student performance, Merchant et al. (2014) The experimental procedure period found that K12 and university related variables were evaluated when evaluating VR evaluations. Thus, in our meta-analysis, the intervention period was also analyzed, and these variables examined the effect of 5.0 formation.

2. Research Method

This survey follows a strict survey procedure to gather, analyze Also include supporting data from studies that address the survey's inquiries.Specifically, these studies were reported according to the systematic review and priority report items meta-analysis (PRISMA) [and complied with the guidelines for conducting systematic reviews of treatments provided in the Cochrane Manual.

2.1 Research Strategy

In April2021, a search of the literature was done on Scopus, one of the biggest amorphous database of citations combining extensive world while guaranteeing the data's best possible quality. and geographical coverage. Therefore, in order to share using the search formula, we have made the decision to refrain from looking for unpublished research in order to assert that all chosen credentials have through a peer-review procedure. In the title, the formless search equation "Virtual reality" is utilized. Additionally, the usage of the time constraint highlights remarks that were published between 2010 and 2021. In this approach, a fairly broad range is formed within which research conducted utilizing empirical realization of current aspirations will take place; This will take into consideration current technical capabilities and not for work associated with potentially outmoded technology. more specifically, Social Sciences, Arts, and Humanities studies written in French, Spanish, or English were the only ones that database searches were allowed to include. Study participation totaled 4658.

2.2 Criteria for Eligibility

Both authors start by looking at all potential articles' titles, keywords, and summaries. This research is taken into consideration as part of the evaluation if it: I consists of experimental investigations with the goal of determining how VR affects academic standing of pupils as a result variable, precisely chosen papers that link this variable to certain academic setups [13]. Achievements such as grade point average, total score, test-taken data, and academic performance. ii) pupils in primary or kindergarten. iii) VR delivery of educational content. iv) developed in a school environment, in a classroomt v) includes a control design for the pretest and posttest. Provide enough data to assess the effect magnitude. vii) If an academic institution's library system or the internet both have access to the complete text. Before making a judgment, a full-text examination of the relevant inquiry is conducted if there is a doubt. As a result, studies that failed to pass the initial screening were disregarded based on the title, synopsis, and keyword analysis. Intercoder reliability was measured in Cohen's kappa, as usual in a literature review, with a concordance of 97.14%.

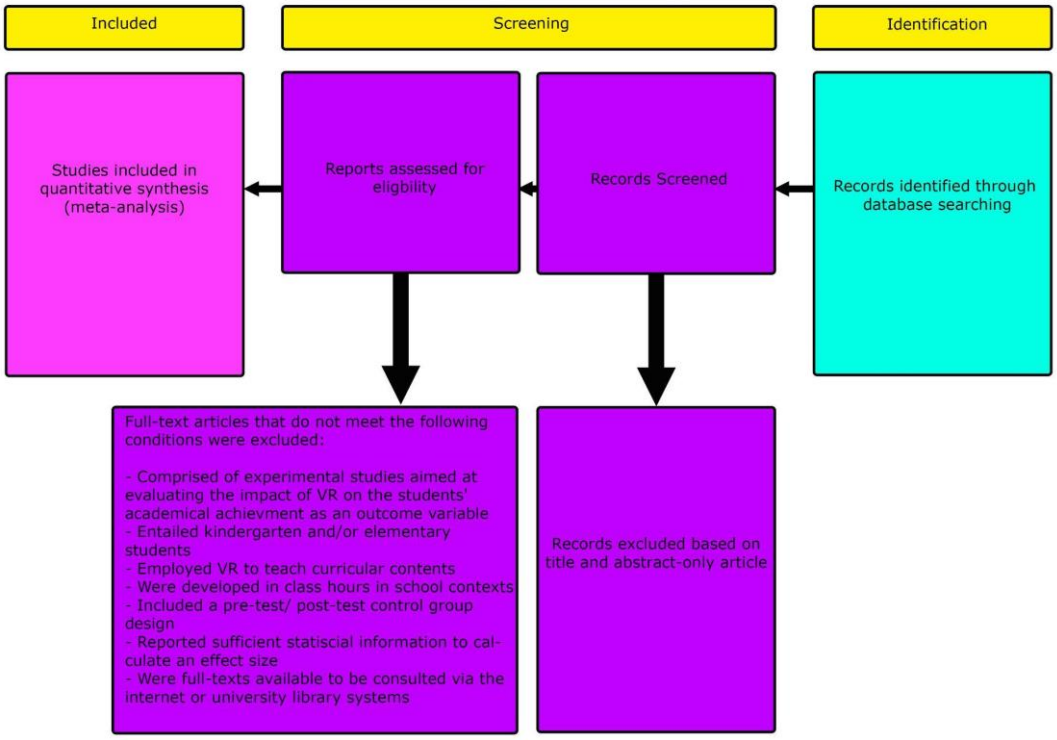
2.3 Coding of Data

The purpose of the data collecting forms is to gather data from the studies they include regarding the key research components. Two writers conducted this procedure and independently examined the text, gathering the following data for each research: author, title, study design, year of publication, sample characteristics (sample size and age distribution), education level, grade level, school topics, and intervention time. To attain consensus, all disputes are settled through dialogue facilitated by outside writers.

2.4 data synthesis and statistical analysis

The meta-goal, analysis's as was already said, is to compile quantitative data from multiple investigations into a single report. Estimating the impact of VR on student learning outcomes is the goal of this meta-analysis. for which purpose is a combined estimation of the 95% confidence interval that corresponds to the effect size (ES) (Cis)[12]. Using the approach, DerSimonian & Laird calculated. Using Cohen's d-index as an ES statistic, The training gains' standardized mean difference was specifically determined (Cohen, 1988). An elevated learning effect in the intervention group's favor is indicated by a positive ES value. According to Cohen (1988), a minor influence with a d value of about 0.2 was thought to exist. a little influence under 0.5 and a big effect beyond 0.8. If the research presents many treatments or comparison groups For the same outcome data, a scientific approach or other measures were offered, They were aggregated to create a single value by utilizing a normalized d-index-based Cohen's mean difference. The variation in the study's overall results was also evaluated using I 2 statistics. Moher et al. claim as much. (2009) I2 values of 0-40% are not considered significant; values of

30-60% are considered moderate non-uniformity. Values between 50% and 90% represent significant non-uniformity, and values above 75% are considered significant non-uniformity. The p-value corresponding to the I2 Additionally, value was considered. Sensitivity analysis was used to evaluate the summary estimates' reliability and ascertain if a single study was primarily responsible for the heterogeneity. Based on the following moderator factors, subgroup analysis was conducted: (1) degree of immersion, (2) level of education, and (3) domain of expertise. Using the technique suggested in, publication bias was evaluated by visually inspecting the funnel chart.The trimandfill method was also used to assess the impact of publication bias on the interpretation of resultsUtilizing the software package Comprehensive MetaAnalysis, statistical analysis was carried out (version 2.2.64).



Picture 2. PRISMA. Flowchart for the selection process of the studies.

3. Findings

3.1 Descriptive results

Following the screening procedure, we found 21 research (Table1) that assessed VR's efficacy for educational outcomes. The majority of the references published in the meta-analysis after2016, despite the fact that the literature review's time frame of 2010–2021 was its primary emphasis. Before this year, just seven articles had really been released. Regarding the kind of the intervention and the degree of immersion, nine research utilized non-immersive virtual reality, three utilized semi-immersive reality, and eight utilized immersive reality. The one-study research design contained two experimental conditions. One of them is the intervention group that uses the immersive reality methodology, and the other group is the intervention group that uses non-immersive VR technology. What is noteworthy about In recent years, the usage of immersive technologies has increased. Despite the fact that earlier research tended to utilize semi-immersive or non-immersive

technologies more frequently, Table 1 demonstrates a considerable rise in the number of studies utilizing immersive technology in recent years.

Regarding the demographic characteristics assessed in the survey, Only three surveys were undertaken among elementary school pupils in the lower grades with just two polls were done among kindergarteners (grades 1 to).One study included students from grades 1-5. Fifteen studies were conducted in the upper grades (grades 4 to 6). Selected studies show that VR is used more often among older students. Looking at the knowledge areas in which the VR intervention is designed, we can see that most of the courses cover STEM subjects (Natural Science (8 courses) and Mathematics (5 courses)). Other works distributed such as History (2), Language (2), Music (1), Sports (1). Lastly, based on the length of the experimental intervention, 11 studies were categorized as short intervention duration (less than 2 hours) and 8 studies were categorized as long duration (more than 2 hours).

3.2 Meta-Analysis

The intervention group benefited from analysis of the impact of VR on learning outcomes, and it was evident that there was significant variability. So, it is possible to dismiss hypothesis H1. Together with the statistical significance of the Q test, this number suggests that the majority of the variability is likely to represent the genuine variance. As a result, we computed pooled ES using a random effects model.

3.3 Sensitivity research

By excluding specific studies from the analysis, the influence of particular research was evaluated. the average impact of educational results, omitting the most significant.

3.4 Subgroup analyses

Subgroup analysis was performed based on moderator variables. The subgroup analysis did not include any studies where the variable being moderated could not be characterized or where the information was not available to categorize the variable being moderated. shows findings from the subgroup analysis [18]. First, for the immersive level, the technology is semi-immersive and non-immersive VR. Therefore, according to Table 2, H2 can be discarded. Regarding the academic background, it is necessary to consider the there are not many studies conducted in kindergartens and primary schools, but the effects of VR were similar in three categories: kindergarten, school baseline and SMA. In terms of the knowledge domain, the maximum effect sizes correspond to music and language studies, but in both The largest impact sizes are found in the fields of music and linguistics, however only one and two articles from each field are a part of each category in both cases. In With eight and five studies, respectively, science and mathematics impacts may be categorized as major and medium effects. The research supports the possibility of rejecting H4[19], [20]. Although the short intervention (less than 2 hours) had a significant impact size and the lengthy intervention had a modest effect, H5 cannot be excluded (Table 2).

4. Conclusion

This meta-primary analysis's goal was to synthesize the findings of many research in order to ascertain how various types of VR impact kids in grades 5.0 in terms of their academic performance. Due in part to the growing effectiveness and expense of the used technology, the study presented here is from the last ten years, during which VR has played a significant role. Our key finding is that VR has a favorable impact on student learning outcomes (5.0), based on the findings attained. Comparing VR to different teaching methods, we discovered

that VR improves learning. Similar to this, the examination of moderate factors might produce key findings for next studies. First off, desktop and semi-immersive VR systems are less successful than immersive VR when used at the K6 level. This result is one of the study's major contributions to the domains of research and teaching. The use of VR is also advantageous for PAUD and primary education. This finding is significant since there hasn't been any published meta-analysis that specifically addresses these two periods. Additionally, VR appears to be beneficial for all fields of study. However, the majority of initiatives are carried out in experimental domains like mathematics and physics in some sectors (sports, history, music), necessitating more study. Last but not least, it is advised that any future VR practice should be a quick fix. Because this method has been shown to be more effective, in less than 2 hours.

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