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Article

Next-Gen Mulsemedia: Virtual Reality Haptic Simulator's Impact on Medical Practitioner for Higher Education Institutions

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Abstract: Immersive technology is one of the emerging trends in education in the twenty-first century, whether that be university training programs, or real-world technical training. However, there has been very little research into the effects and consequences of virtual reality. Various types of eLearning have been used to transmit information in recent years, and especially for medical education, virtual reality plays a vital role in terms of providing effective training; the virtual reality app bridged the gap between traditional learning and practical exposure. This unified reality environment enables users to simulate real-life scenarios and obtain useful information that would otherwise be unavailable. In the real world, it is difficult to grasp. In India's education sector, virtual reality technology is also being researched at an early stage. The goal of this research paper is to assess and explain the impact of virtual reality simulators on medical students' desire to learn. In the classroom, the core motivation hypothesis is used to boost motivation. The attention, relevance, confidence, and satisfaction (ARCS) model influenced the interpretation of virtual reality's impact on student motivation and content update implementation. The study examined the numerous variables of virtual reality simulators and their impact on medical education, using the ARCS model as a factor analysis. According to the study, students wsould learn more and be more motivated if virtual reality simulators were used. Attention, relevance, satisfaction, and confidence indicators were used to develop motivational variables, and the results were significant. We have taken the sample of 607 students' data for this analysis, through which we have identified the potential of VR made available to students, as well as the faculty, which has the potential to transform medical education. Instructors may be wary of incorporating new technology like VR into their curriculums, but with the support of their students' learning habits, this may not be a problem. It may help instructors feel more confident, while also enhancing the relationship between faculty, librarians, and students.

Keywords: ARCS model; virtual reality; ICT (information and communications technology); simulation; 3D animation

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1. Introduction

"VR" stands for "virtual reality", which is a process that makes the object in front of the camera look more real. This improves the viewer's experience. In other words, aug-mented reality brings the intangible into the realm of the visible. The term "virtual reality" [1] refers to the process of using technology to superimpose precise sounds, images, and text, on top of our current environment. Immersive technology will sometimes use the camera on a smartphone to add more visual information to a live view of the area around it. Smartphone games, which are becoming more and more popular, are one of the most common ways that augmented reality is used in everyday life. Pokémon Go is an example of augmented reality in action. CNET reports that in 2016, "Pokémon Go" became a world-wide phenomenon, with more than 100 million people playing at its peak. Forbes says that it has received more than two billion dollars so far and that it keeps getting more money every day. Mixed reality (MR), also called virtual reality (VR), is a technology that combines real-world and computer-generated environments to create new settings and representations that coexist with real-world objects, and can talk to them in real-time. This phenomenon is also known as virtual reality [1]. Because so many people now own mobile devices and have found new ways to employ them, immersive technology may now be applied to a wider range of situations. Virtual reality (VR) is the educational system of the future's future reality. The pace of transition in the classroom is unparalleled in any other setting. Because of the arrival of technology, classrooms now include significantly more interactive components, which are beneficial to a great number of young people. The use of virtual reality (VR) in the classroom in India is still in its infant stages of development. The implications and impacts of employing virtual reality in educational settings have received little attention from researchers. Augmented reality programs for smartphones are now available, and educational apps for smartphones are becoming more widely available [2]. These applications can be used to teach a wide variety of educational subjects. Although a significant amount of study has been conducted on the applications of virtual reality in education, it is important to keep in mind that this discipline is still in its infancy. In light of recent advancements in economics, society, and education, it has become clear that enhancing both the quantity and quality of vocational education is one of the most important steps that can be taken to prepare for the subsequent phase of technological revolution and industrial transformation [3]. Higher vocational schools are conducting research to determine how to undertake educational reform in order to meet the demands of industry and businesses for work skills that can no longer be met by traditional teaching techniques. These demands are becoming increasingly difficult to meet. In order to expedite the process of educational reform, a variety of interactive online learning systems, that are supported by multimedia computer technology and network technology, have been developed. These teaching platforms are still unable to meet the needs of students in terms of experiments, practical exercises, and training [4]. This is due to their inability to support real-time interaction between teachers and students and to overcome problems connected to rough time and space allocation. They are also unable to provide students with direction and supervision, which will help them sort through the confusion they are experiencing. As a direct consequence of this expansion, a novel form of technology known as virtual reality (VR) has emerged, and is currently making significant headway in the educational sector. Building a three-dimensional virtual environment with computer graphics rendering, and other technologies, can result in an improved user experience if the environment is designed properly. This is the essence of what virtual reality technology, sometimes known as VR technology, entails: giving the user the impression that they are actually participating in the activities taking place in the virtual environment, and using the information that is being made available to them. It is possible that gaining firsthand experience and actively engaging with the content of the virtual environment can help improve the quality of the data [5].

It is possible to engage in social activity with other people and perform routine chores while in a digital setting by using VR software (VR). Real-time VR technology is a catch-all term for a wide range of subfields, including voice recognition and stereo sound, network and communication technology, sensor and stereo display technology, and re-al-time digital information delivery methods. Users will be able to fully appreciate the sensory experience, which is the most important aspect of the system, when VR docks flawlessly, as shown in Figure 1. When implementing a comprehensive teaching reform in business data at private higher education institutions with limited resources, actual data (yn), economically viable, and widely available VR (VR) interactive teaching gadgets must be designed (Tn). In computer-assisted teaching, computers are used to carry out a variety of teaching activities, such as the discussion of teaching materials, the design of teaching procedures, and the execution of teaching training approaches with students in a dialogic manner. Computer-assisted teaching has grown tremendously in the field of education since its inception in 1958, and subsequent development with multimedia computers in the late 1980s.

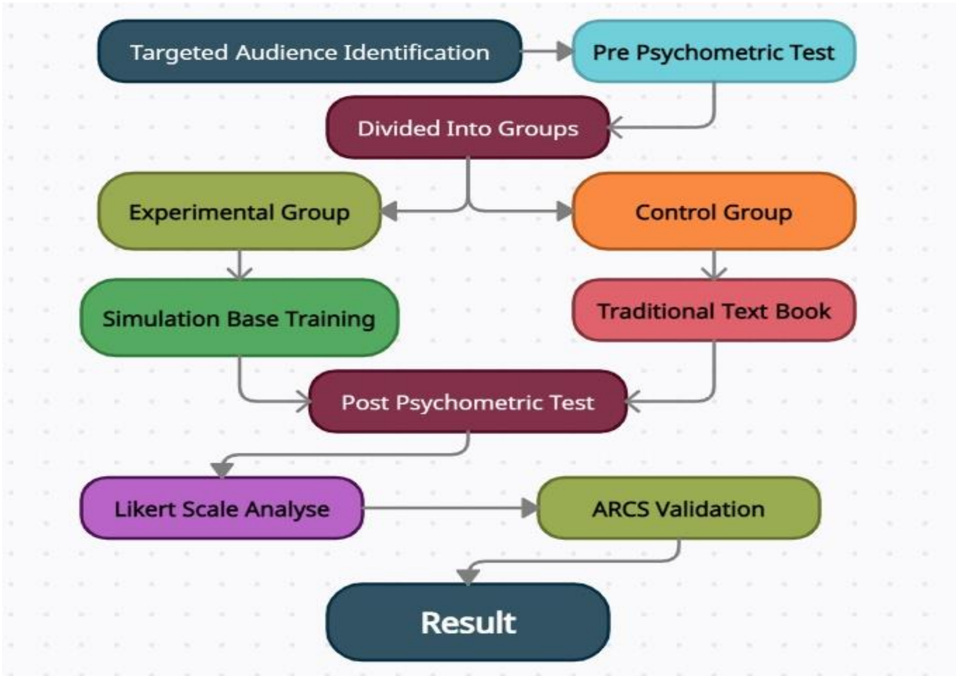


Figure 1. Proposed model integrating VR in education to improve learning and practice for the medical concepts.

1.1. Virtual Reality and Education

Virtual reality is a relatively new concept. It has been used in the field of education for a long time, but its use is still in its early stages. Although there is still a long way to go before this technology can be used in the classroom, several methods introduce virtual reality into educational settings. A helpful resource for science fields, such as mathematics, biology, physics, and chemistry, is the application of enhanced realism as a practical basis for their studies. Consider the following scenario: a biology lesson in which cells are visualized by placing marks on images or text, is presented.

On the other hand, virtual reality is geared toward subjects as diverse as history, linguistics, and geography, and can provide the contextual awareness of authors, sites, and historical events. An example is a bookmark on a literary work that provides the author with additional information and photographs. This method offers students a personalized and exciting experience that piques their interest. The comprehensive and dynamic atmosphere facilitates the learning and transfer of ideas for those who attend the conference [6]. It piques the students' attention, resulting in more exciting and instructive classes. Interactivity makes it possible to communicate with one another. Learning incentives can be obtained by overcoming typical classroom boredom through the use of technology. Due to this, students can approach problems from a different viewpoint and apply what they have learned to their own lives; it prepares pupils for life in the modern-day. The drawbacks of adopting virtual reality in the classroom for educational purposes are that students can go through a 'slow learning stage'. It all comes down to placing the testing and absorption of concepts in the forefront of the quest for the simulator's solutions. In today's society, more truth is frequently used as entertainment; consequently, it is critical to learn how to redirect it toward the educational sector, rather than only for pleasure purposes.

Several different training materials and devices must be used to adapt virtual reality. What immersive technology is developed, implemented, and integrated into formal and informal learning environments has a significant influence on its educational usefulness [7]. The topic of whether augmented reality advances encourage and deliver actual learning is a critical one to consider and answer. It may be more advantageous for educators to think of augmented reality as a concept rather than a specific type of technology. It is vital to involve educators in creating successful augmented reality teaching software, as doing so increases the possibility that augmented reality will be employed in education.

1.2. Advantage of 3D Animation and Virtual Reality on Medical Education

Hardware and software are typically included in virtual simulation expenses. High-end virtual reality (VR) equipment costs around GBP 3000 for a complete setup (laptop and headset). However, software expenses are often less than one-tenth of what it would be for a physical simulation, regardless of the vendor. As a result, virtual reality may save a significant amount of money in the initial setup and ongoing costs.

These technologies not only save money, but they also free up classroom space and teacher time. Virtual reality (VR) technology may be used by a faculty without further training, as much of it is commercially accessible hardware and user-friendly software. A faculty member may be required to be present for some VR installations, while others do not; the use of cases of the VR device frequently dictate this.

In a 2×2 m area, VR can give a clinical situation in under 5 min of setup. While a VR simulation is running, other simulations in the center can continue to run without interfering with the experience. For example, instructors may devote more time to teaching students how to communicate more effectively, or conducting in-person simulations, neither of which would be ideal for virtual reality.

If a virtual scenario can assure consistency in quality and protocol adherence, it should be objective and standardized so that medical facilities may incorporate their most recent procedures and ensure professionals have experienced utilizing them before seeing patients.

The design of customized simulation courses is also possible with many immersive systems. These systems are also capable of generating a lot of performance data. This information is useful for guaranteeing utilization, promoting learner engagement, and identifying students who may benefit from additional training.

1.3. Contribution

The objective of this paper is to fill a research gap by applying immersive virtual reality (VR) in higher education. Immersive virtual reality (VR) technologies are being incorporated into medical higher education to design the types of instructional content, body parts, other medical instruments, and immersive technologies, to facilitate VR-based medical learning. Theoretical learning theories that have been improved have been used as the foundation for the design and development of virtual reality (VR) applications for use in higher education. How have learning outcomes been evaluated, and what types of assessment methodologies have been used to improve student learning? It also aids in identifying areas of higher education where virtual reality (VR) has been used for teaching and learning.

2. Review of Literature

The incorporation of multimedia elements into educational experiences has been a significant contributor toward the goal of making education more enjoyable. As a direct result of all of the problems that have been discussed up until this point, education pertaining to human anatomy now makes use of the opportunity to make use of technology in order to improve learning [8]. When compared to textual descriptions, the visual anatomical representations of complicated systems can aid in the process of understanding those systems. Mobile virtual reality (MAR) environments use immersive technology and are portable or mobile, allowing them to be used outside of a purpose-built setting, in contrast to traditional virtual reality (VR) environments. MAR environments are also referred to as augmented reality (AR) environments. MAR applications can now be implemented practically thanks to the proliferation of modern mobile technologies, such as those found in smartphones [9].

As you are about to learn in the following section, human anatomy, despite its many advantages, also has a few drawbacks that you should be aware of. There are a number of challenges to overcome, some of which include the storage of dead bodies, moral challenges, the quality, and the restricted number of cadavers that are available, the limited number of hours that the laboratory is open, and a low degree of recall. This work addresses these limitations in the learning of human body anatomy by presenting a learning style that uses MAR to mobilize the learning environment and, as a result, increases student performance in the subject area. MAR stands for mobile ad hoc networking, and it is the foundation of this learning style. The utilization of a physical interface paradigm makes it possible to interact fluidly between the real and virtual worlds and to manipulate objects [10]. This is made possible thanks to the fact that the paradigm was developed. Because it creates a learning environment that is linked to the regular classroom, students are able to learn in settings that are not considered to be part of the school's official classrooms, and even beyond the school's physical area.

2.1. Learning Behavior

We looked at randomized and cluster-randomized controlled studies that compared any virtual reality (VR) intervention with any control intervention for pre- or post-registration health professional education. We included health professionals who had credentials based on the International Standard Classification of Education's Health Field of Education and Training (091). Virtual reality (VR) therapies may be provided on their own or in conjunction with more conventional educational methods (i.e., blended learning). We included research on the use of virtual reality for both cognitive and nontechnical aspects of health professions education, as well as research on all types of virtual reality delivery devices and immersion levels. In the investigations that were included, the development of psychomotor or technical skills did not require the use of any additional probes, handles, or other pieces of supplementary equipment. We considered research that compared virtual reality (VR) or mixed learning with traditional schooling, other forms of digital education, or another VR intervention.

Within the realm of virtual reality (VR), we differentiated between 3D models, the virtual patient, or virtual health professional (VP or VHP), and surgical simulations. Although we did include studies in which virtual patients participated in a virtual reality (VR) environment, we did not include studies in which virtual patients participated in non-VR settings. These latter studies are the subject of a separate review that focuses on virtual patients alone (simulation). We did not include any studies that were carried out by students or by medical professionals who practice conventional, alternative, or complementary medicine. We also did not include studies that utilized a cross-over design because there was a possibility that the effects would carry over.

In the traditional education sector as a whole, it has emerged as a critical resource over the course of the past few years as a means of developing new educational methods, particularly in terms of teaching methodologies. This is particularly true in the context of the global education industry. However, there are some disadvantages associated with the use of computer-assisted instruction [10]. Traditional computer-assisted learning systems have restrictions on how lessons can be delivered and the types of responses that can be given, which makes it challenging to accommodate students whose skill levels and knowledge bases vary greatly. It can also be difficult to figure out how different teaching strategies and appropriate teaching methods can help students of varying levels. This can be a challenging aspect of teaching. Computer-assisted education is being held to higher standards in the hopes that it will one day be better presented, better evaluated, and even easier to apply in the classroom setting. Virtual reality (VR) and computer-assisted instruction (CAD) have been combined in order to improve the quality of teaching. This has resulted in an overall improvement in the quality of teaching as a result of an improved presentation of information. Because of recent developments in virtual reality technology, computer-assisted education has been given a jolt of much-needed adrenaline, which is a breath of fresh air. It is anticipated that the utilization of the humanized interactive teaching method will become more widespread [11].

2.2. Immersive Teaching

As a direct consequence of this, more people will acquire knowledge about virtual reality while they are attending school. The concept of "immersive teaching" is going to emerge as a hot topic in discussions about the overhaul of the educational system. Since this style of education takes place entirely within the confines of a classroom setting, the term "immersive teaching" was created to describe it. The ability to interact with one's environment, to become fully immersed in one's surroundings, and to conceptualize one's surroundings, are three of the most notable aspects of virtual reality technology. Things in a virtual world are able to respond in an accurate manner to information that is received by a computer as a result of significant technological advancements. These technological advancements include sensor technology, computer graphics technology, voice recognition, and processing technology (along with network technology), and so on. This includes the development of a teaching platform that is accessible at a low cost and is utilized by a large number of people, as well as an online learning platform that includes an organic mix of point reading in real-time [12,13].

The interaction of student feedback is the medium through which information is transmitted; errors are fixed, the status of the system is monitored, and learning can be supported by feedback. Over the course of the last century, a significant amount of time and energy has been invested by researchers and designers in the pursuit of an under-standing of the processes by which individuals acquire knowledge. The majority of sys-tems require additional input, which must be provided by the system designer. One ex-ample of this is the sound of an engine. There are a variety of potential topics for feedback, including information on the performance of the operator, the status of the system, and monitoring data. Wide variations are possible both in terms of the quantity and the nature of the information that can be gleaned from a system's feedback. The purpose of this re-search was to identify some recommendations for best practices pertaining to the design of feedback.

Following the examination of a wide range of fundamental research issues, some of which are predicated on the findings of earlier studies, and some of which are predicated on regions that have not been adequately investigated, it was determined that further investigation is required in both categories. An investigation into the subject matter, academic field, and learning domain in which I-VR has been applied, has been carried out by our team.

Enhancing the learning behavior in areas where immersive virtual reality may offer a medical education advantage, traditional medical teaching techniques, and non-immersive teaching methods in terms of the quantitative learning outcomes that may be achievable, we analyze the experimental designs used in the research, with a particular emphasis on the methods that are used to measure the outcomes of learning and to carry out the I-VR intervention. Research on educational I-VR applications has the goal of informing the field's future experimental and applied practice.

3. Research Model:

Most educational institutions have chosen online education over traditional methods of instruction in order to protect their employees and students from the COVID-19 pandemic. Online learning is becoming increasingly popular in almost every country. Generally, students in most Indian medical institutes are frequently taught how to deal with situations on an individual basis. The institutes frequently do not teach them how to work together as a group of people due to Government regulation of human body availability for practice, and the lack of ICT integrated infrastructure support. When a doctor starts working in a hospital, he or she will have their first hands-on experience with a group. Due to the fact that this is a bad concept, many mistakes are made on a regular basis.

In developing countries, there is also a requirement to implement the mixed (MR) and extended reality (XR) immersive technology implementation in medical education that includes experiential, gamified, and interactive simulation-based learning. New challenge arises for educational institutions as well as for instructors, who must adapt to a new mode of learning as quickly as possible. To overcome this barrier and improve the learning and teaching methodologies within the Indian medical education system, the outcome of this research will be critical in this endeavor. Simulations help to bridge this gap while also providing team building opportunities. Most medical errors are caused by doctors' lack of training in non-technical abilities, which accounts for the vast majority of them. Virtual-reality-based training sessions can be extremely beneficial in preparing doctors for delicate and complicated procedures that require precision, fewer complications, and less trauma to the patient. Anyone can watch operations in real time thanks to technological advancements in recent years. We proposed a virtual-reality-based training and education module for cardiologists, neurosurgeons, critical care and emergency medicine doctors, among other specialties.

As shown in Figure 1, the proposed research will follow quantitative and qualitative research methodology. An immersive technology supported application will be created base on heart block disease. This research is targeted to a group of medical students who have not learned about a topic, such as heart working function. This group will be divided into two teams: a control group, and experimental group. The control group will study through traditional text books and the experimental group will learn through immersive technology.

The HTC Vive Kit Pro was used to create an interactive training pitch simulation model. In order to identify user position, attention, and active quick response, data was collected using a VR simulator, which then communicated the results to the VR devices through wireless devices. Users' activities, the interactive 3D learning of humans, and the practice of medical concepts, are depicted in Figure 2.

ARCS [14] model is a motivational design technique that combines four categories: attention (A), relevance (R), confidence (C), and satisfaction (S), Figure 3.

Figure 3 shows the proposed SEM analysis for the impact of VR simulators on medical education using the ARCS model of learning motivation; SEM analysis. A questionnaire was distributed to about 607 students via Google, and responders were classified according to numerous criteria, including gender, degree of education, and the use of VR [15]. Stratification sampling was used for data collection; it is an effective method for revealing the statistical characteristics of a population by focusing on a fraction of that group. Selecting a small number of items to stand in for the complete set is a sampling technique. With the use of stratified sampling [4], a large, diverse group of people can be broken up into smaller, more manageable groups with known levels of similarity. Similarly, it is standard practice to employ some form of previous knowledge to partition a population of N items into subsets of N1, N2, etc., up to NL. We evaluate the suggested stratified sampling method by comparing the population and sample means for flow size and duration. In Figure 2, for instance, we examine how the population mean of flow sizes compares with the sample mean. That is what we have done for all four paths that the traffic may take. This type of comparison is crucial because it provides statistical support for extrapolating from a smaller subset of the population. Options include the type of stratification to be used, the size of the sample, the number of strata, the type of stratifying variable, and the type of deployment. Our first alternative is a stratification strategy, and we looked at three variations: static assignment using exponential limits for strata; dynamic assignment using the clustering algorithms CLARA and K-means; and manual assignment using exponential limits for strata. To fit the data so that the model-implied covariance matrix matches the actual one, select a parameter estimation technique after specifying a model and the empirical covariance matrix; estimation methods have distinct distributional assumptions and discrepancy functions to reduce.

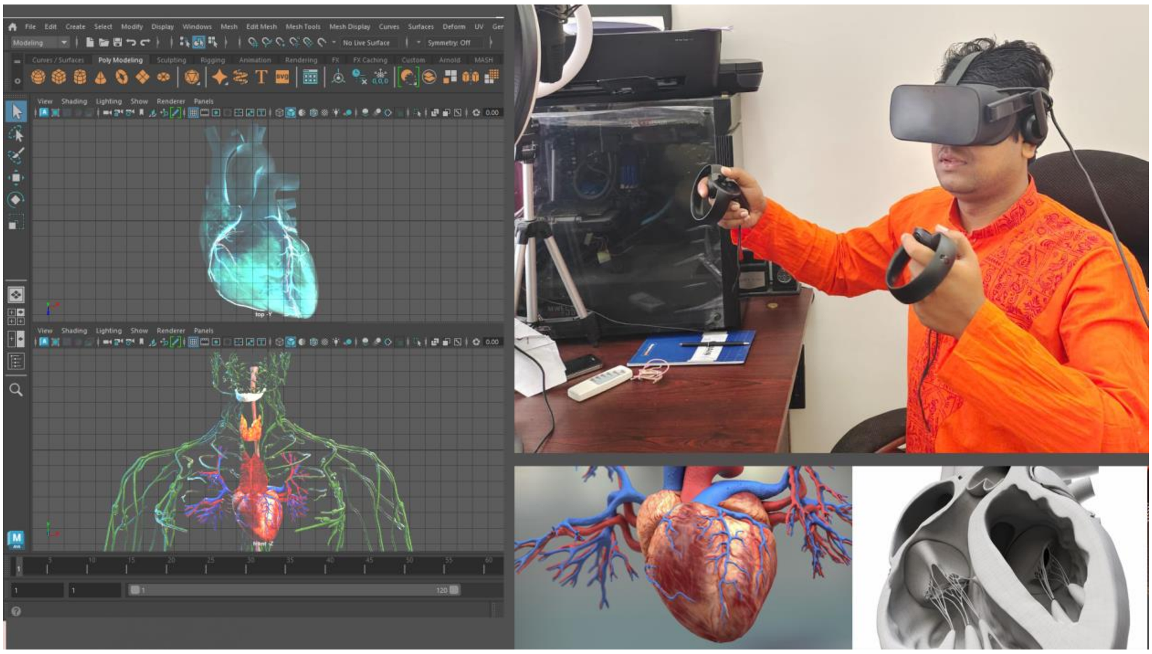
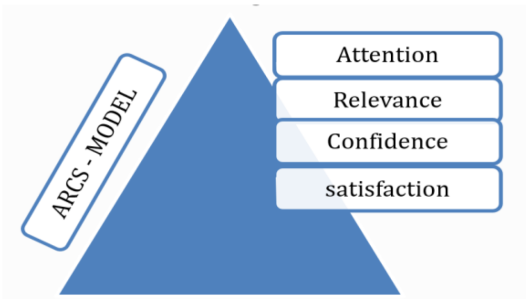
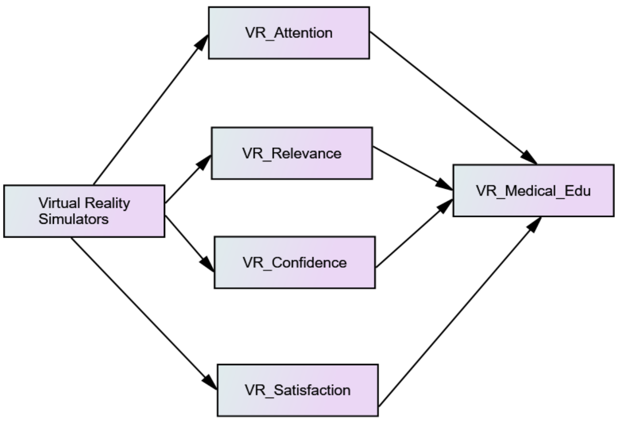


Figure 2. Interactive 3D human body to learn and practice the medical concepts.



(**a**)



(**b**)

Figure 3. (**a**) ARCS model, (**b**). V.R. relevance and VR Simulators.

The classification of ages, below 18, 18–21, 22–25, 26–29, and 30 or above, respondents participated forming 34%, 43.4% 21.3%, 8.0%, and 21.6%, respectively; gender classification was 393 males, 213 female, and one other respondent who participated, forming 64.7%, 35.1%, and 0.2%, respectively. According to educational level participants, 115 respondents were P.G. students, 469 were U.G. students, 23 were others; 18.9%, 77.3%, and 3.8%, respectively. Cronbach's alpha coefficient is the simplest and most well-known way to measure internal consistency and is the first approximation to the construct validation of a scale. Cronbach's alpha coefficient should be understood as a measure of the correlation of the items that make up a scale. The determination of Cronbach's alpha is indicated in one-dimensional scales that have between a greater number of parameters value should always be reported in the specific population where the scale was used.

We have used Likert-type scales (5 scale) in this research. Table 1 shows that the subtest on new media and medical education has a significant influence on students' overall assurance in their medical knowledge. [16,17]. Cronbach's alpha scores for all subscales exceed 0.931, indicating that the scale is trustworthy and genuine. Table 2 also shows the greatest alpha value of 0.931 for all of Cronbach's NM&HE dimensions. Cronbach's alpha values for the perceptions' sub-scales are 0.763 for V.R.-VR simulators, 0.758 for VRA-VR attention, 0.752 for VRR-VR relevance, 0.752 for VRS-VR satisfaction, 0.752 for VRME-VR and medical education, and 0.598 for the overall reliability analysis for the impact of VR.

Table 1. Reliability study result for impact of a VR simulator on medical education using the ARCS model of learning motivation dimensions.

Dimensions	Number of Attributes	Cronbach's Alpha
VR_SIMULATORS	6	0.7631
VR_ATTENTION	6	0.7582
VR_RELEVANCE	6	0.7563
VR_CONFIDENCE	6	0.7575
VR_SATISFACTION	6	0.7523
VR_MEDICAL_EDUCATION	6	0.5984
VR_IMPACT_MEDICAL_EDUCATION	Cronbach's alpha No. of. Items 36	0.995

Table 2. Conversion of learning motivation questionnaire to different scale.

Positive Statement		Negative Statement	
Answer	**Score**	**Answer**	**Score**
Strongly agree	1	Strongly disagree	4
Not Likes	2	Not Likes	3
Agree	3	Agree	2
Strongly Support	4	Strongly agree	1

4. Result and Discussion

The ARCS model of learning motivation aspects was used to examine data on interpretation variables in the VR simulators on medical education, as shown in Table 2. The data analysis approach employed is: (1) the paired sample t-test; and (2) translating the qualitative value to quantitative value, computing the percentage, and categorizing it into five groups. The qualitative value in the learning motivation questionnaire was converted to a quantitative value using the Riduwan (2014) approach, as shown in Table 2 and Figure 4.

Figure 4. Reference to changing percentages of data.

4.1. Analysis of Karl Pearson Correlation Coefficient on Proposed Model

For any pair of random variables (X, Y), let $F(x, y)$ be its bivariate cumulative distribution function. The classical Pearson correlation coefficient r of (X, Y) is defined as follows:

$$r = \frac{\mathrm{Cov}(X, Y)}{\left[\mathrm{Var}(X)\mathrm{Var}(Y)\right]^{\frac{1}{2}}},$$

and Kendall's τ is defined as follows:

$$\tau = 4 \iint F(x, y) dF(x, y) - 1.$$

We have considered n number of samples during data collections subjected to verification of outcome. A random variable U destroys component 1, sample B governed by random variable V destroys component 2, and sample C governed by random variable W destroys both components simultaneously. We refer to such a system as bivariate homogeneous shock (BHS) model. Clearly, under this model the life length of component 1 is $X = \min(U, W)$ and that of component 2 is $Y = \min(V, W)$.

We have focused on ARCS model. Denote $g(\theta) = \iint u^{\theta}(x \odot y)dxdy$, and $f(\lambda, \alpha, \beta) = \iint u^{\lambda}(x)u^{\alpha}(y)u^{\beta}(x \odot y)dxdy$. When $u(x) = 1 - x, 0 \leq x \leq 1$, we have,

$$\begin{aligned}
& g(\theta) = \iint u^{\rho}(x \odot y)dxdy = 2\int_0^1 (1 - x)^{\beta}dx \int_0^x (1 - (1 - y)^{\theta})dy = \tfrac{\theta}{(\theta+1)^2(\theta+2)}. \\
& f(\lambda, \alpha, \beta) = \iint u^{\lambda}(x)u^{\alpha}(y)u^{\beta}(x \odot y)dxdy \\
& = \iint_{x \geq y} u^{\lambda}(x)u^{\alpha}(y)u^{\beta}(x)\{1 - u^{\beta}(y)\}dxdy \\
& + \iint_{x<y} u^{\lambda}(x)u^{\alpha}(y)u^{\beta}(y)\{1 - u^{\beta}(x)\}dxdy \\
& = \tfrac{1}{\alpha+1} \cdot \tfrac{1}{\lambda+\beta+1} - \tfrac{1}{\alpha+1} \cdot \tfrac{1}{\lambda+\alpha+\beta+2} \\
& - \tfrac{1}{\lambda+\beta+1} \cdot \tfrac{1}{\alpha+\beta+1} + \tfrac{1}{\alpha+\beta+1} \cdot \tfrac{1}{\lambda+\alpha+2\beta+2} \\
& + \tfrac{1}{\lambda+1} \cdot \tfrac{1}{\alpha+\beta+1} - \tfrac{1}{\lambda+1} \cdot \tfrac{1}{\lambda+\alpha+\beta+2} \\
& - \tfrac{1}{\lambda+\beta+1} \cdot \tfrac{1}{\alpha+\beta+1} + \tfrac{1}{\lambda+\beta+1} \cdot \tfrac{1}{\lambda+\alpha+2\beta+2} \\
& = \tfrac{\beta}{(\alpha+\beta+1)(\lambda+\beta+1)(\lambda+\alpha+\beta+2)}.
\end{aligned}$$

Thus, we obtain

$$r = \frac{\beta}{(\lambda + \alpha + \beta + 2)} \cdot \sqrt{\frac{(\lambda + \beta + 2)(\alpha + \beta + 2)}{(\lambda + \beta)(\alpha + \beta)}}.$$

Denote

$$\Gamma = \frac{r}{\tau} = \frac{\lambda + \alpha + \beta}{\lambda + \alpha + \beta + 2} \cdot \sqrt{\frac{(\lambda + \beta + 2)(\alpha + \beta + 2)}{(\lambda + \beta)(\alpha + \beta)}}.$$

We want to show $\Gamma > 1$. Denote $\alpha + \beta = u, \lambda + \beta = v$, and $\lambda + \alpha + \beta = w$. Then

$$\begin{aligned}
\Gamma & = \tfrac{r}{\tau} = \tfrac{w}{w+2}\sqrt{\tfrac{u+2}{u} \cdot \tfrac{v+2}{v}} \\
& = \tfrac{1}{1+\left(\frac{2}{w}\right)}\sqrt{\left(1 + \tfrac{2}{u}\right)\left(1 + \tfrac{2}{v}\right)}.
\end{aligned}$$

Clearly, we have, $\max\{u,v\} \leq w \leq u+v$. With a little bit notational confusion, we relabel $\frac{2}{u}, \frac{2}{v}$ and $\frac{2}{w}$ as u, v, and w, respectively. Then, we have, $w \leq \min\{u,v\}$. Without loss of generality, we assume $u \geq v$, and then

$$\begin{aligned} \Gamma &= \tfrac{1}{1+w}\sqrt{(1+u)(1+v)} \\ &\geq \tfrac{1}{1+v}\sqrt{(1+v)(1+v)} = 1. \end{aligned}$$

As we can see, the equality holds only when $u = v = w$, that is, $\alpha = \lambda = \beta = 0$. Hence, when the three parameters are not all zero, $\Gamma > 1$, and thus $r > \tau$.

Consider

$$\Phi = \lim_{\beta \to 0^*} \frac{r}{\tau} = \frac{\lambda+\alpha}{\lambda+\alpha+2}\sqrt{\left(1+\frac{2}{\lambda}\right)\left(1+\frac{2}{\alpha}\right)}.$$

In a similar way, we can show that $\Phi > 1$. We can show that Φ can be any number that is larger than 1. Let $\alpha = k\lambda$, then

$$\Phi = \frac{\sqrt{(1+\lambda)(1+k\lambda)}}{1+\left(\frac{k}{1+k}\right)\lambda}.$$

As $k \to 0, \Phi \to \sqrt{1+\lambda}$, which can be any number that is larger than 1.

Denote $\Psi = 2r - 3\tau$, then

$$\Psi = \frac{2\beta}{(\lambda+\alpha+\beta+2)}\sqrt{\frac{(\lambda+\beta+2)(\alpha+\beta+2)}{(\lambda+\beta)(\alpha+\beta)}} - \frac{3\beta}{\lambda+\alpha+\beta}.$$

Since Ψ is symmetric about α and λ, the minimum or maximum of Ψ will be attained on $\alpha = \lambda$. So, we just need to show that the minimum or maximum of Ψ will be between -1 and 1.

When $\alpha = \lambda, \Psi$ becomes

$$\begin{aligned} \Psi &= \tfrac{2\beta}{(2\alpha+\beta+2)}\tfrac{\alpha+\beta+2}{\alpha+\beta} - \tfrac{3\beta}{2\alpha+\beta} \\ &= \tfrac{2\beta(\alpha+\beta+2)(2\alpha+\beta)-3\beta(2\alpha+\beta+2)(\alpha+\beta)}{(\alpha+\beta)(2\alpha+\beta)(2\alpha+\beta+2)} \\ &= \tfrac{N}{D}, \end{aligned}$$

where

$$\begin{aligned} N &= -\left[\beta^3 + \beta^2(3\alpha+2) + \beta\left(2\alpha^2 - 2\alpha\right)\right], \\ D &= \beta^3 + \beta^2(5\alpha+2) + \beta\left(8\alpha^2+6\alpha\right) + 4\alpha^3 + 4\alpha. \end{aligned}$$

We have

$$\begin{aligned} D + N &= 2\alpha\beta^2 + \left(6\alpha^2+8\alpha\right)\beta + 4\alpha^2(\alpha+1) > 0. \\ D - N &= 2\beta^3 + (8\alpha+4)\beta^2 + \left(10\alpha^2+4\alpha\right)\beta + 4\alpha^2(\alpha+1) > 0. \end{aligned}$$

Hence, $\Psi = \frac{N}{D}$ will be between -1 and 1. Which show that Pearson correlation coefficient have high impact on the identified parameters of sample size and value -1 to 1, it verifies the proposed model parameters.

Table 3 showing the coefficient of correlation between virtual reality simulators and the ARCS model [18,19], attention is 0.638, indicating that there are positive connections of 63.8% between virtual reality simulators and the ARCS model, attention on coordination is significant at the 1% level. The coefficient of correlation between virtual reality simulators and ARCS model, relevance is 0.607, indicating positive connections of 60.7% between virtual reality simulators and ARCS model, relevance on coordination, which is significant at the 1% level. The coefficient of correlation between virtual reality simulators and ARCS model, concentration is 0.652, indicating that there are positive connections of 65.2% between virtual reality simulators and ARCS model, concentration on coordination, which is significant at the 1% level. The coefficient of correlation between virtual reality simulators and ARCS model, satisfaction is 0.547, indicating that there are positive connections [20] of

54.7% between virtual reality simulators and ARCS model, satisfaction on coordination, which is significant at the 1% level.

Table 3. Karl Pearson Correlation Coefficient [21] between factors of analysis on impact of a virtual reality simulators on medical education using the ARCS model of learning motivation dimensions.

Correlations									
Factors of Analysis on Virtual Reality Simulators on Medical Education		**VR_SIMULATORS**	**VR_ATTENTION**	**VR_RELEVANCE**	**VR_CONFIDENCE**	**VR_SATISFACTION**	**VR_MEDICAL_EDUACTION**	**VR_IMPACT_MEDICAL_EDUACTION**
VR_SIMULATORS	Pearson CorrelationValue	1.00	0.638 **	0.607 **	0.652 **	0.547 **	0.731 **	0.756 **
	Value of Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.000
VR_MEDICAL _EDUCATION	Pearson Correlation value	0.741 **	0.889 **	0.911 **	0.884 **	0.916 **	1	0.998 **
	Value of Sig. (2-tailed) value	0.000	.000	0.000	0.000	0.000		0.000
VR_CONFIDENCE	Pearson Correlation Value	0.632 **	0.773 **	0.783 **	1	0.739 **	0.884 **	0.894 **
	Value of Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000	0.000
VR_RELEVANCE	Pearson Correlation	0.617 **	0.805 **	1	0.783 **	0.814 **	0.911 **	0.915 **
	Value of Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000	0.000
VR_SATISFACTION	Pearson Correlation value	0.557 **	0.738 **	0.814 **	0.739**	1	0.916 **	0.903 **
	Value of Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000
VR_ATTENTION	Pearson Correlation	0.648 **	1	0.805 **	0.773 **	0.738 **	0.889 **	0.896 **
	Value of Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000	0.000
VR_IMPACT_MEDICAL_EDUCATION	Pearson Correlation Value	0.746 **	0.896 **	0.915 **	0.894 **	0.903 **	0.998 **	1
	Value of Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	
**. Correlation is significant at the 0.01 level (2-tailed).								

Note: ** Denotes significant at 1% level.

The coefficient of correlation between virtual reality simulators and the impact of virtual reality simulators on medical education using the ARCS model of learning motivation dimensions is 0.756, indicating that there are positive connections of 75.6% between virtual reality simulators and the impact of virtual reality simulators on medical education using the ARCS model of learning motivation dimensions on coordination [22], which is significant at the 1% level. Similarly, the other variables are positively associated with one another.

HYPOTHESIS: 1

Null hypothesis (H0): The hypothesized model has a good fit.

The alternate hypothesis (H1): The hypothesized model does not have a good fit.

The model's fitness was evaluated using structural equation modelling (SEM), which was applied to the data collected as shown in Table 4 and Figure 5.

Table 4. Model fit summary of structural equation model.

Model Fit Indices	Output/Result	Recommended Values
p value	0.175	*p*-value > 0.05
Chi-square/degree of freedom (x^2/d.f.)	1.837	≤5.00 (Hair et al., 1998)
Comparative Fit index (CFI)	0.999	>0.90 (Hu and Bentler, 1999)
RMSEA	0.057	>0.06 to 0.08 with confidence interval
PCFI	0.067	Sensitive to model size
NFI	0.999	≤1 (Values close to 1 indicate a very good fit)
PCLOSE	0.000	<0.005

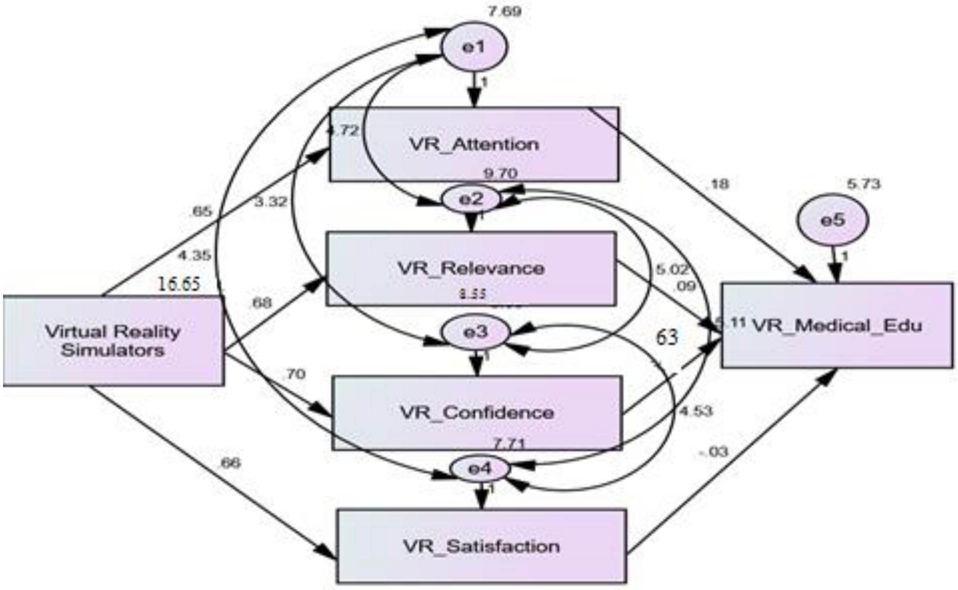


Figure 5. VR based structural model for learning.

If explanatory-theory discrepancies are small, its sensitivity to differences from predicted values with rising sample sizes might be troublesome. This study claims the Chi-square exact-fit test is the sole SEM fit test. Correctly scaled approximation fit indices are not sample size-sensitive. "Tests" of model fit should not replace these indices. The "consequences" of adopting an explanatory model should be balanced against theory-relevant metrics' predictive accuracy. This might break our impasse. If there are no "competing" models, there is no reason to compare them. In the testing of the analytical model to determine the accuracy and validity of the survey instrument, the structural model was assessed using the AMOS version 23, following the recommendations of [18]. Structural equation modelling (SEM) is beneficial for finding the causal relationship between variables and ensuring that the model is compatible with the data set being analyzed.

In structural equation modelling, the data is compared to a theoretical model developed. The design was evaluated using the chi-square/degrees of freedom 2(x^2/df), the CFI, the RMSEA, the NFI, and the P-CLOSE, as shown in Table 4. As a consequence, the probability of $p = 0.175$ was estimated. The Chi-square score of 1.837 indicates that the model is well-fitting in this case.

Chi-square statistics may be influenced by a sample size more prominent than 100 (in this study, 607 participants) to indicate that there is a significant degree of likelihood ($p = 0.175$), according to [23]. Because of this, this model is examined to be used for further investigation during the goodness of fit phases. Model fit metrics that are widely used include the Chi-square/degree of freedom (x^2/df), the comparative fit index (CFI), the approximation root means square error (RMSEA), the nonlinear fit index (NFI), and the

PCLOSE. The findings of the structural modelling of AMOS are shown in Table 4, which shows the system fit index.

According to [24], the following characteristics of an effective template: Table 4 shows a Chi-square/D.F. value of 1.837, which is less than 5.00, indicating an excellent match between the two variables. Confirmatory factor analysis (CFA) (0.999) and the normed fit index (NFI) were used to analyze the data (0.999) 1 is the Chi-square equivalent. A very excellent match is represented by values close to one, indicating a perfect match overall. A good fit may be determined by the PCLOSE value (0.000), which is less than 0.005, and the root mean square approximation error (RMSEA) is 0.070, which is less than 0.08, suggesting that the model is acceptable. Table 5 representing the regression weights of maximum likelihood estimates.

Table 5. Regression weights: maximum likelihood estimates.

Independent	Relationship	Dependent	Estimate	S.E.	C.R.	P
VR_Attentio	<—	VR_ Simulators	0.652	0.042	15.353	***
VR_Relevance	<—	VR_ Simulators	0.677	0.048	14.186	***
VR_Confidence	<—	VR_ Simulators	0.696	0.045	15.532	***
VR_Satisfaction	<—	VR_ Simulators	0.661	0.043	15.547	***
VR_Medical_Edu	<—	VR_ Attention	0.180	0.067	2.682	0.007
VR_Medical_Edu	<—	VR_ Satisfaction	−0.026	0.075	−0.342	0.732
VR_Medical_Edu	<—	VR_ Confidence	0.633	0.063	10.004	***
VR_Medical_Edu	<—	VR_ Relevance	0.087	0.066	1.325	0.185

*** Not Applicable.

4.2. Essential Tests of Individual Parameters

The standardized coefficients and pertinent test data are presented in Table 6. It is defined as the amount of change in the dependent or mediating variable for every one-unit change in the variable that predicts it, expressed as a standardized regression coefficient, as well as its standard error (abbreviated S.E.) and the standard error estimate (also known as the critical ratio, abbreviated C.R.) Column P represents the probability value associated with the null hypothesis, stating that the experiment is a complete failure. Figure 3 depicts the parameters included in the investigation of the impact of virtual reality simulators on medical education, which was conducted using the ARCS model of learning motivation dimensions structural architecture. During the confirmatory factor assessment process, 597 students picked and answered 30 questions relating to the factors of analysis for the impact of virtual reality simulators on medical education using the ARCS model of learning motivation dimensions. As shown in Figure 3, augmented reality simulators (VR simulators) play an essential role in the learning process in higher education. Alternatively, the confirmatory variable test is referred to as an assessment approach. By exposing the approximation square error, the root illustrates how the model will fit the population covariance matrix with unknown parameter values when the parameters are uncertain [25]. According to [26], CFI, RMSE, or root mean square approximation error, is a good match for the original data set.

Table 6. *T*-test significance difference between using virtual reality simulators for medical education reducing stress and anxiety among the respondent. One-sample test: test value = 3.

	t	*p*-Value
t-test significance difference between using virtual reality simulators for medical education reducing stress and anxiety	25.004	0.000
	28.313	0.000
	21.075	0.000
	29.343	0.000
	26.743	0.000

HYPOTHESIS: 2

Null hypothesis (H0): There is no significant difference between using virtual reality simulators for medical education reducing stress and anxiety among medical students. The alternate hypothesis (H2): There is a substantial difference between using virtual reality simulators for medical education reducing stress and anxiety among medical students.

Since the *p*-value is less than 0.01, the null hypothesis is rejected at a 1% level regarding the virtual reality simulators for medical education reducing stress and anxiety among the respondent. Virtual reality simulators used in the finest medical training facilities have improved anatomical position learning and minimized surgical time in the real world. Increased patient and physician safety, and good psychological impacts on learners, resulting in lower training costs and effort has improved and their anxiety has been dramatically decreased because of VR-based training. Additionally, they have inquired about employment needs in the city. Needlestick, vehicle shop, and injury prevention, are all terms that come to mind when thinking about injuries.

Medical and stressful situations can both be life-threatening. It is difficult, unnatural, or expensive, to train new doctors to handle medical emergencies before they face them in real life. The failure to properly portray the stress and intensity of real-world trauma management in VR. It offers one-of-a-kind training options. Education, reports, and almost-effective call center training are provided. Reducing surgical durations and the real-world setting improves both physician and patient safety, has beneficial psychological effects on learners, and lowers training costs and efforts, as well as total consequences. Among the 607 participants, 207 males and 155 female medical interns said VR training has dramatically decreased their worry regarding occupational and needlestick injury prevention. VR simulators, according to them, help students cope with tension and anxiety when pursuing medical education, as shown in Table 6 and Figure 6.

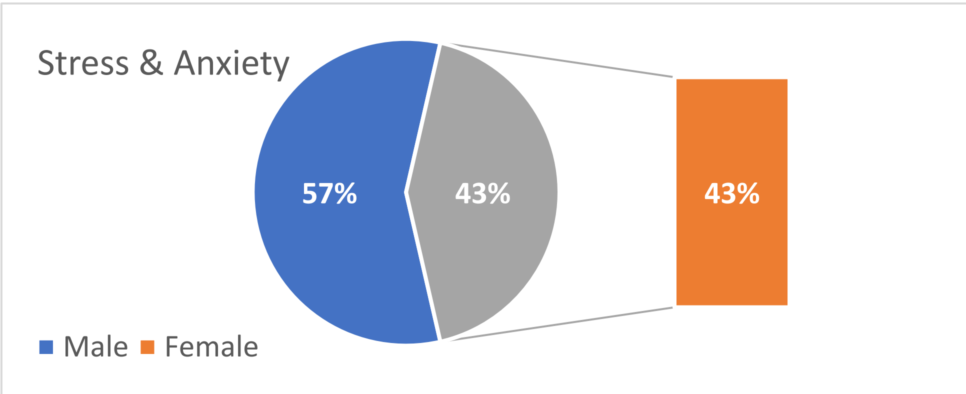


Figure 6. Stress and anxiety analysis of proposed model.

HYPOTHESIS: 3

Null hypothesis (H0): There is no significant difference between using virtual reality simulators for medical education during COVID-19. The alternate hypothesis (H2): There is a substantial difference between using virtual reality simulators for medical education during COVID-19.

The coefficient of correlation between virtual reality simulators and their use during a pandemic situation during COVID-19 is 0.741 percent, indicating that there are positive connections of 74.1% between virtual reality simulators and their use during COVID-19 on coordination, which is significant at the 1% level. Therefore, the null hypothesis was rejected at a 1% level. Most nations implemented strict lockdown measures to prevent the coronavirus from spreading during the pandemic. Several medical colleges and institutions use virtual reality to enhance traditional teaching methods and medical turning in hospitals. Due to restrictions on in-hospital access, training providers gave students with virtual patient-based instruction, interrogation, and simulated clinical scenarios on a case-by-case basis, all via virtual reality, as represented in Table 7. Medical students see VR training as a reliable platform for first cleaning evaluation. The VR training is suitable for identifying activity, and its utility in therapy alternatives has been recognized. In addition, students anticipated that the scope of virtual reality instruction would increase apprenticeship at the bedside of a patient.

Table 7. Karl person test significance difference between using virtual reality simulators for medical education during COVID-19.

Correlations		**V.R._ Simulators**	**V.R._ during Pandemic**
V.R._ Simulators	Pearson Correlation	1	0.741 **
	Sig. (2-tailed)		0.000
VR_ during pandemic SATISFACTION	Pearson Correlation	0.741 **	1
	Sig. (2-tailed)	0.000	

**. Correlation is significant at the 0.01 level (2-tailed).

4.3. Analysis of Result

VR has a positive impact on the level of student involvement. The use of VR has been shown in studies to increase students' interest and motivation in the study of scientific topics. Students can experience a sense of wonder, cleverness, and power, thanks to augmented reality technology, which may be the primary motivator for their excitement. The ARCS modelling system: a person's level of interest in the subject at hand, as well as their confidence, sense of accomplishment, and overall contentment (ARCS). VR technology's impact on students' desire to learn has been analyzed using the motivational architecture paradigm. Students need to be interested in the architecture, understand its relevance, have faith in it, and feel confident utilizing technology that is based on ARCS for the VR system to be successful. Given that both the VR app and the medical education scale have Cronbach's coefficient alpha values that are greater than 0.70, this indicates that there is a high degree of internal consistency (V.R. app and medical education model with the only measure of performance). The overall Cronbach alpha value of the VR app and more education dimension is 0.938, which is higher than the cut-off value of 0.70. Confirmatory factor analysis reveals that the VR app and medical education scale used in this investigation (VR and higher education) system with output evaluation alone is a good fit for the data that was collected, as shown in Table 8. This research presents a five-factor model that, based on the feasibility and statistical significance of relevant parameter estimations, offers a satisfactory explanation of the VR app and medical education framework for the influence of new media technology in learning on higher education. Hopefully, this research will help students have a clearer understanding of the significance of VR simulators technology in medical education and how it impacts student learning. If we take a deeper look at how immersive technology is being used to teach medical students, we may conclude that it has a bright future and room for expansion; as a result, education departments should focus on implementing and standardizing its use.

There was a sample of 670 students participating in the table sample of participants, whose skills were evaluated as a consequence. Research contrasted VR-based therapies with traditional learning, and the aggregate pooled estimate of student performance across all 22 studies indicated a significant increase in post intervention cognitive skill scores for intervention groups when compared with control groups. Refs. [26–28] analyzed and contrasted the performance of a variety of VR formats with regard to the learning of cognitive abilities. We were able to integrate the findings of two research that both supported the use of more interactive VR (moderate impact size, poor confidence evidence), as shown in Table 9.

Table 8. Comparative analysis of result with exiting method.

Outcomes	Comparative Risk Analysis	Student	Studies (n)	Quality of Evidence in Terms of Performance	Comments
Knowledge scores after the exam, either via a lab experiment or an exam. There will be no more follow-up once the examination has been completed.	Compared to the control group, the intervention group's mean knowledge score was 0.44 standard deviations (SD) higher (0.18 to 0.69 SDs).	207	22	Moderated attitudes about the intervention are tracked using a post-intervention survey. Only the time immediately after the intervention is allotted for follow-up visits.	The data from one trial [26,27] were removed from the pooled analysis because it presented mean change scores for the group.
Post intervention satisfaction scores: measured via survey. Follow-up duration: immediate postintervention only.	Not estimable.	100	8	Low	Five studies [28–33] reported incomplete outcome data or lacked comparable data. Therefore, these studies were excluded from the analysis.
Post-Examination survey are used to test post-Exam skills. Only the time immediately after the exam is allotted for follow-up visits.	There was a 1.12 SD difference between the mean skill score in the intervention group and the mean score in the conventional learning group (0.81 to 1.43 higher).	188	18	Moderated	As one research provided incomplete outcome data, as one study evaluated mixed outcomes, and as one study presented self-reported outcome data, three studies were omitted from the analysis.
Post intervention attitude scores: measured via survey. Follow-up duration: immediate postintervention only.	The intervention group's mean attitude score was 0.19 standard deviations higher (0.35 lower to 0.73 higher) than the conventional learning group's mean attitude score.	105	5	Moderated	N/A

Table 9. Test results for the significance of the paired sample *t*-test.

Decision Criteria	Motivation Aspects	Sig Value. (Two Tailed)	Decision	Conclusions
H0 is rejected if sig. (two tailed <0.025)	Attention	0.000	H0 is rejected	There is a significant difference between attention before and after using multimedia.
	Relevance	0.224	H1 is accepted	There is no significant difference between relevance before and after using multimedia.
	Confidence	0.000	H0 is rejected	There is a significant difference between confidence before and after using multimedia.
	Satisfaction	0.000	H3 is rejected	There is a significant difference between satisfaction before and after using multimedia.

By enabling students to engage with AR content on their smartphones, augmented reality can make it easier for pupils to learn new information and remember it. Educators will work in conjunction with subject matter specialists to determine the most effective means of incorporating specific qualities into the curriculum. Implementation may be expensive due to the fact that individual schools may not have the necessary funding and rely on subsidies. The new reality of education presents a wealth of opportunities; nevertheless, there is also a significant amount of opportunity for development. When educators use virtual reality (VR) technology in the classroom, they need to exercise caution in order to ensure that students and teachers are able to utilize a range of educational methods. To get the most out of new media and higher education, educators need to become more skilled in the use of technologies such as virtual reality.

5. Conclusions and Future Work

The purpose of this study was to evaluate the elements that determine the impact that virtual reality simulators have on medical education by using the ARCS model of learning motivation aspects as a guide. This study examines and analyzes the impact of virtual reality simulators on medical education by applying the ARCS model of learning motivation factors. It does so by focusing on the positive aspects of augmented reality (VR) application. The suggested model (VR simulators and medical education scale with particular adjustments) is calibrated with data from SWAYAM for 670 students' data. There are six key variables, including VR application, attention, relevance, self-assurance, and happiness, together with a degree from an accredited post-secondary institution. This notion explores motivation by looking at it from the standpoint of intrinsic motivation. Internal motivation may be affected by difficulty, interest, the degree of control, and creative output. A powerful will and an optimistic outlook are required in order to maintain one's motivation to study. Students can be motivated to continue their education without the need for additional pressure or reward from the outside world because of the intrinsic desire they already possess.

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