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Gamified Learning and Assessment Using ARCS with Next-Generation AIoMT Integrated 3D Animation and Virtual Reality Simulation

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Abstract: In higher education institutions (HEI), particularly in biology and medical education, the use of 3D animation, virtual reality, and simulation offers great potential in terms of enhancing learning and engaging students. Higher education researchers are still investigating virtual reality's possibilities and outcomes in various fields. This study focuses on the effects of 3D gamification using an Artificial Intelligence integrated Internet of Medical Things (AIoMT) implemented with virtual reality application for biology and medical students to learn about the human brain. Nowadays, both theoretical and practical education frequently incorporate virtual reality and augmented reality. Virtual tours of the human body's systems are offered to biology students so that they may comprehend such systems' functions. This study focuses on the use of 3D animation, virtual reality, and simulation in medical education, with a specific focus on the effects of a 3D gamification app using the Internet of Medical Things (AIoMT) on medical professionals' passion for learning. This study uses the ARCS model and SEM analysis to examine the impact of virtual reality on students' motivation and learning. The results show that virtual reality positively impacts motivation and the understanding of the concept-to-execution process through practice and simulation-based training. To assess how well students are learning, what they are analyzing, and how well they can understand the objects of analysis, a 3D-simulation-based and user-feedback-based design has been developed using the proposed research methodology. According to this article's findings, a smartphone app that uses virtual reality can help medical professionals better understand the concept-to-execution process through practice. VR simulation-based training, as well as Biology teachers or medical colleges, can offer high-definition 3D VR models rather than organs in jars to understand the human anatomy and its functions more experientially and effectively.

Keywords: gamification; ARCS; AIoMT; 3D animation; ICT; virtual reality simulation

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Citation: Kumar, A.; Saudagar, A.K.J.; Alkhathami, M.; Alsamani, B.; Khan, M.B.; Hasanat, M.H.A.; Ahmed, Z.H.; Kumar, A.; Srinivasan, B. Gamified Learning and Assessment Using ARCS with Next-Generation AIoMT Integrated 3D Animation and Virtual Reality Simulation. *Electronics* **2023**, *12*, 835. https://doi.org/10.3390/electronics12040835

Academic Editor: Stefanos Kollias

Received: 19 December 2022
Revised: 26 January 2023
Accepted: 2 February 2023
Published: 7 February 2023

1. Introduction

Gamified learning is a teaching method that incorporates game design and game mechanics elements into the learning experience. It is designed to make learning more engaging, interactive, and fun for the learners. The relevance of gamified learning to a study depends on the study's specific research question and objectives. For example, a study may investigate the effectiveness of gamified learning compared to traditional methods of instruction or the impact of gamified learning on student motivation and engagement.

As technology advances and creates new immersive and fantastical worlds, the education of medical students and the provision of adequate digital tools to teachers must adapt to take advantage of new opportunities [1]. Educators, researchers, policymakers, and digital designers need to set the direction for the use of technology in education rather than allowing technology to dictate the opportunities. To fully realize the potential of the metaverse as a 3D, global, interconnected, immersive, and real-time online place, innovative approaches are needed to link the real world with augmented and virtual reality experiences. This will enable a more effective and engaging way of learning and teaching in the medical field. Virtual reality is used to educate medical students. Accordingly, they can access previously inaccessible areas through VR. They need not even operate on an actual subject. The theoretical knowledge of medical students and new physicians is enhanced by virtual reality. With virtual reality, learners can examine 3D medical models in detail, which is impossible with physical models, or converse with AI-controlled virtual patients whose attitudes and behaviors can be easily modified. Virtual reality (VR)-based [2] medical training software allows medical school graduates and healthcare professionals to gain practical experience in a risk-free environment. The virtual reality software used in healthcare can simulate difficult, dangerous, or costly scenarios.

One of the most widespread [3] ways that VR is making its way into people's daily lives is through the proliferation of mobile games. Virtual reality (VR) provides users with greater immersion, presence, and engagement compared to other information technologies [4]. Virtual reality (VR) shows potential as a technique that can improve higher education [5]. VR Enhancing students' academic performance is remarkably helpful for experiential learning [6]. By providing students with the freedom to study in their own ways, immersive virtual environments may offer rich experiences and boost the value of courses.

To create new landscapes and images where physical and digital items may exist and communicate in real time, developers of what is known as "mixed reality" (MR) combine aspects from both the real and virtual worlds. Since it uses current technology and can be accessed on mobile devices, virtual reality has become more widely available in recent years [7]. The proliferation of smartphones has lowered the barriers towards access to virtual reality (VR). There is no doubt that VR will revolutionize classroom instruction shortly. Change occurs in the classroom more quickly than in any other setting. Interactive components that take advantage of modern technology are becoming increasingly common in schools, and there is a lack of literature on the future of virtual reality education research in India because the field is still in its growing stage. An increasing number of virtual reality (VR) smartphone applications are becoming accessible in various subject areas [8].

Virtual reality (VR) is a technology that completely immerses users in a computer-generated environment while blocking out the real world. Augmented reality (AR) and augmented virtuality (AV) both involve overlaying digital information on top of the natural world rather than completely replacing it. VR may be chosen over AR or AV because it allows for a more immersive experience. In VR, users are fully immersed in a digital environment and can interact with it as if it were real. In contrast, in AR and AV, users are still aware of the natural world and may not feel as fully immersed in the digital experience. Another reason for the selection of AR over VR pertains to the use case. VR is useful for gaming, simulation, and training applications, wherein a fully immersive experience is desired. Whereas AR and AV are more appropriate for navigation, product visualization, and maintenance instruction. Furthermore, VR typically requires more advanced technology and hardware, such as head-mounted displays and motion tracking, which can be more expensive and complex to develop and implement. On the other hand, AR and AV can be implemented in many devices and can be less expensive to build and implement.

Virtual reality may benefit higher education in various ways, including by simply modifying existing courses, extending existing courses to provide students with more experiential learning opportunities, and providing new content made feasible by VR. However, challenges like this must be conquered. We believe many problems may be reduced or avoided by offering improved guidance for teachers. Just as we do not expect any teacher to be able to create a projector to display slides, we should not expect them to be able to make virtual worlds either. Research on the issue is limited; hence, the potential of VR in education has not been thoroughly explored. The mental labor needed to comprehend material and carry out an activity is called the "cognitive load". The amount of information displayed, the ease of navigation, and the complexity of the 3D environment are all elements that might impact cognitive load in the context of VR and 3D representations.

1.1. Problem Statement

The global pandemic has highlighted healthcare's importance and caregivers' sacrifices. Healthcare education must be updated with the latest technology to improve caregivers' skills and decision-making abilities in stressful situations. Proper training and education can boost the confidence and skills of biology students and healthcare professionals, leading to better patient outcomes and advancement in the healthcare sector. Research has shown that when the cognitive load is high, it can become more difficult for users to learn and retain information. Therefore, designing VR and 3D environments is crucial to minimize cognitive load and maximize learning effectiveness.

1.2. Major Contribution

Healthcare education can be divided into theoretical knowledge and practical skills. Theoretical knowledge provides a foundation of understanding about the human body and various medical conditions, while practical skills allow for the application of such knowledge in real-world situations. It is crucial for biology learners and medical students to develop effective practical skills as healthcare deals with the delicate and complex human body, and applying knowledge in a practical setting is essential for providing proper care to patients. This paper helps to analyze and use virtual reality in medical education and offers opportunities for educators to create a more engaging and interactive curriculum for students. The optimal use of these digital tools has the potential to reform the biology and medical education sectors and provide a more immersive learning experience for students. Additionally, the use of virtual reality in biology and medical education can also help bridge the gap between theoretical knowledge and practical skills, allowing students to experience and apply their learning in a realistic, simulated environment, thus enhancing the overall learning experience.

2. Literature Review

Multimedia features have had a significant effect on increasing the enjoyability of education. Given the challenges previously mentioned, human anatomy courses must make the most of the opportunity to integrate technological improvements into their curricula. Anatomical illustrations can help explain complicated structures. It is conceivable that virtual reality (VR) can be taken out of its traditional settings—a dedicated room or similar structure—and made more mobile.

A Mobile Animated Short Mobile or transportable Virtual Reality (MAVR) is a subgenre of broader Virtual Reality (VR) technology. The availability and low cost of mobile technology such as smartphones have made MAVR applications a reality [9]. Despite the many benefits, there are also drawbacks to studying human anatomy. The storage of cadavers, ethical concerns, a lack of suitable cadavers, small sample sizes, irregular lab hours, and a low knowledge retention rate are only some of the problems that need to be solved. Educators have been examining the Metaverse as a potential tool in this regard. Facebook's announcement that it will begin advertising itself under Meta has reignited interest in this area of research and development.

The phrase "metaverse" is a portmanteau of the prefix "meta," meaning "beyond," and the word "universe," meaning "a parallel or virtual environment related to the actual world". In his 1992 science fiction novel Snow Crash, Neal Stephenson used the word "metaverse" to describe his fictional replacement of the Internet with a virtual reality system. In this book, the protagonists and antagonists alike use digital avatars to navigate a virtual world and escape from their problems [10]. The findings show that the Metaverse may be used in higher education to give teachers and students access to unique educational approaches, ICTs, and emerging technologies through interactive and immersive experiences.

The author of [11] discusses the use of the metaverse by students with disabilities in the classroom and calls for further research into the best practices for designing accessible and inclusive Metaverses for education. The growing virtual flexibility in space and time may allow students with disabilities and special needs to engage more fully [12]. One example of how the Metaverse may be used is in a problem-based learning (PBL) situation. In this setting, wherein questions and discussions are continually intertwined, the Metaverse can provide students with a platform for problem solving. The study by [13] is a good example of such a situation. A recent systematic literature review [14] provided an overview of research focusing on virtual reality (VR) design in academic settings.

The analysis found that many existing engineering, computer science, and astronomy applications concerned teaching or learning how to perform specific tasks. For instance, one study described the development and testing of a virtual reality (VR)-based training system that allowed engineering students to assemble and disassemble an engine [15]. As a bonus, a recent survey of VR app stores provides a comprehensive analysis of the available VR educational apps. The authors concluded that most of the available apps are meant more as a supplement to classroom instruction than as a replacement for it.

Taken as a whole, these studies show that several virtual reality (VR) application scenarios exist in higher education but that most VR learning tools are not built for prolonged use [16]. In addition, the VR learning applications available today have been recently surveyed and reviewed in depth. According to the authors, most of the apps on the market are intended to be used in addition to traditional classroom learning rather than in instead of it. Taken as a whole, these studies show that a variety of VR application scenarios for higher education are already recognized but that current VR learning tools are not often designed for long-term usage.

A recently published systematic literature review [17] offers a comprehensive overview of such experimental research, comparing the learning outcomes of VR teaching approaches to those of alternative learning methods. A study of the students found that the brief VR simulations enhanced their interest in and comprehension of topography.

In a quasi-experiment, the author of [18] had undergraduate biology students watch three different simulations, either as movies or through virtual reality headsets. The comparison study's results showed that the VR conditions led to a more significant improvement in both information acquisition and knowledge retention. In a separate investigation, researchers built a virtual reality (VR) gaming environment for teaching and mastering mathematical concepts.

By facilitating novel types of distant connection and cooperation, 5G cellular networks have the potential to radically alter the way we learn. An integral aspect of the Education 4.0 paradigm is the ability of students to operate remotely and interact with physical objects in real time with low latency and high dependability. The paper discusses the benefits and drawbacks of using 5G networks in the classroom and presents a prototype of a remote lab to illustrate how 5G may be used in education [19].

As a result of the COVID-19 pandemic, there has been an uptick in healthcare innovation and new business models that utilize virtual worlds to create an alternative healthcare system. Metaverse technology, a universal and immersive virtual world made possible by VR and AR, is now a part of healthcare's digital transformation, with the intention to digitize the sector's traditional societal web.

This paper, [20], provides a thorough overview of the recent advancements in the healthcare metaverse across seven fields: telemedicine, clinical care, education, mental health, physical fitness, veterinary medicine, and pharmaceuticals. It looks at healthcare-related metaverse applications, discusses pertinent technology issues and potential fixes, and lists challenges that need to be resolved before the industry can fully embrace the metaverse.

The purpose of the following paper, [21], was to examine the effects of a 6-week POINT training program on the off-axis neuromuscular control performance of the lower limbs during trained and untrained functional activities on slippery surfaces. Training on the off-axis may help prevent knee injuries caused by off-axis loadings since the training group demonstrated substantial improvements in off-axis neuromuscular control performance and decreased instability during untrained activities.

The purpose of the research in [22] was to present a novel auto-encoder-based Electro-Cardiogram (ECG)-based Identity Recognition (EIR) system, dubbed Personalized Auto Encoder (PerAE), to increase the privacy and security of EIR systems. When a person registers with PerAE, a miniature auto-encoder model (called Attention-MemAE) is trained on their unique memory patterns. The Attention-MemAE employs a memory module and two attention methods to boost the auto-encoder's capabilities. PerAE's customized autoencoder helps it work faster while utilizing less memory. The method enhances EIR systems' flexibility, scalability, and maintainability. The experimental results demonstrate that after five minutes of collecting 500 pulse samples, PerAE may reach 90% identification accuracy for a user.

The authors of [23] propose the use of a spatial 3D augmented reality (AR) display to give patients with upper limb impairments visual and tactile input throughout their rehabilitation. They made augmented reality (AR) renditions of three rehabilitation games and compared how well users fared in these experiences compared to those provided by traditional two-dimensional (non-immersive) virtual reality (VR). Cognitive load (CL) was applied to participants to mimic the effects of cognitive impairments brought on by disability. The findings indicate that AR improves user performance, particularly in dynamic activities that necessitate fast reactions and motions. The study also discovered that CL and non-CL patients had comparable levels of AR performance, suggesting that AR can mitigate the harmful consequences of CL.

Virtual reality (VR), augmented reality (AR), and mixed reality (MR) are all examples of eXtended-reality (XR) technologies that are explored in [24] to enhance autistic people's quality of life. Human–computer interaction (HCI) and presence were also analytical aspects of these investigations. The research showed that most studies utilized virtual reality as an interventional technique (81.82%). In comparison, augmented reality was used in 16.67% of studies, and magnetic resonance imaging was used in 1.52% studies. The findings show that technical aspects, technological affordances, and research characteristics strongly correlate with selecting specific XR platforms [25,26]. The authors provide suggestions for academics and educators to keep in mind while developing and deploying XR technology in classroom settings for autistic children.

3. Research Methodology

The paradigm discussed [27] is a motivational design strategy synthesizing many motivational concepts and theories. The four pillars of this paradigm are Attention (A), Relevance (R), Confidence (C), and Satisfaction (S). The ARCS model, which illustrates the connection between concentration, self-assurance, positive outlook, and feelings of contentment, is shown in Figure 1.

The experience-based questionnaire was distributed to the biology learners who experienced learning through a VR simulator. The responders were classified into different groups based on various criteria, such as gender, degree of education, and the use of VR. Stratified sampling was used for data collection, a method that allows for the statistical characteristics of a population to be revealed by focusing on a specific subset of that group. It is a technique wherein a small number of items are selected to represent the entire population. This can effectively gather information about specific population segments and make inferences about the larger group. Scale dimension refers to the size or magnitude of a system concerning other similar systems. In the context of 3D animation and virtual reality, scale dimension refers to the size and proportion of virtual objects concerning real-world objects; in this study, we have taken a scale (of 1 to 5). One is the lowest, and 5 is the highest scale dimension. In Biology and medical education, virtual reality and 3D animation allow students to interact with virtual models of the human body and medical equipment at different scale dimensions, which can provide a more realistic and immersive learning experience. Additionally, manipulating the scale dimension of virtual objects can help students understand the relative size and proportion of different structures within the body.

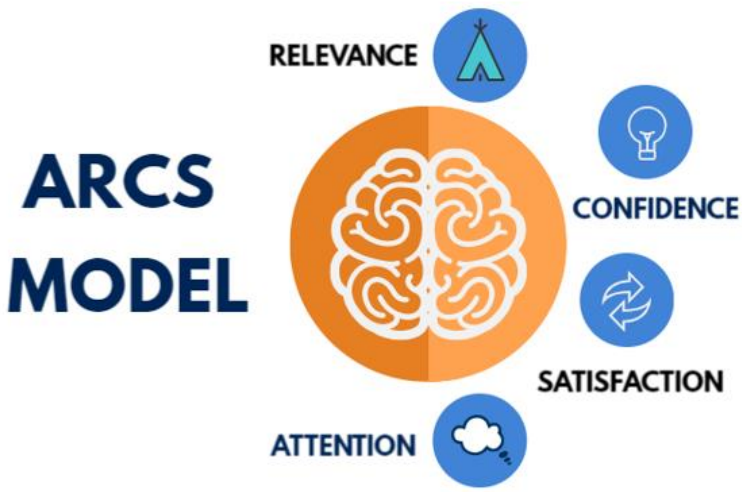

Figure 1. ARCS model.

The following abbreviations are used in this study: VRR (Virtual Reality Relevance), VRA (Virtual Reality Attention), VRC (Virtual Reality Confidence), VRE (Virtual Reality Education App), VRS (Animation Virtual Reality Satisfaction), and VRR_ Impact (Virtual Reality and Higher Education learners).

Figure 2 shows the ARCS model of learning motivation as applied to a planned SEM investigation of the effects of VR on higher education. The metaverse, and IoT in particular, will affect the use of Digital Twins, which are software representations of existing assets or systems created using artificial intelligence, by providing more realistic practice environments. Training in extreme real-world conditions (such as severe weather or cyber disasters) may be performed through virtual simulations employing digital twins in the metaverse. This allows us to design and test training approaches when we cannot do so in the real world. Training simulators will help humans and AIs learn to work together to spot problems early on and mitigate their effects in the real world as the realism of the metaverse grows.

As an increasing number of digital replicas of real-world items are added to the metaverse system, it will start to appear very similar to our own reality (in terms of aspects such as cars, buildings, factories, and people). We will be able to run different long-term planning scenarios; choose the best designs for our energy, transportation, and healthcare systems; and manage these systems dynamically in response to changes in the real world (e.g., more renewable sources, new diseases, population migration, or demographic changes) thanks to this advance system of virtual simulation. Human teams may use these simulations to better respond to events as they unfold and find solutions to problems by planning for the month, week, or even day [28]. Next, AI will analyze the results and utilize that knowledge to improve the reaction in the next event. The headset allows users to see the VR environment. The base stations can follow the sensors on the headgear. There are delicate sensors in the headset. The proximity sensor's lens should not be covered or scratched. The controllers and headgear receive signals from the base stations. No material should be used to cover the front panel. When the base stations are activated, some adjacent infrared sensors, such as those used by an IR TV remote control, may be impacted. The controllers have sensitive sensors. Covering or damaging the sensor lenses should be avoided.

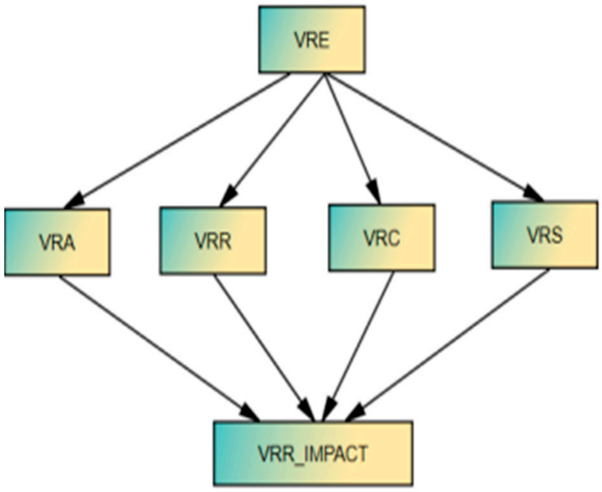

Figure 2. Proposed Model VR_ Impact.

An educational platform has been created using VR technology, including MS KINECT. The training pitch simulation model was constructed using a training simulator made with Autodesk MAYA [29], Unreal Game Engine, the Microsoft HoloLens immersive head-mounted display, HTC Vive Kit Pro, and Oculus Rift. Utilizing the virtual reality simulator, actions such as variations in the user's position, attention, and active quick response are identified, and then the experiment's findings are transmitted to the VR devices using wireless devices [30].

4. Result and Discussion

A total of 612 students participated in this experiential learning program regarding the human brain using 3D immersive Virtual reality technology, as shown in Figure 3. The collected information was segregated according to gender, educational attainment, and VR participation. Table 1 shows that 6% of the respondents were under the age of 18, 43% were between the ages of 18 and 21, 21.4% were between the ages of 22 and 25, 7.8% were between the ages of 26 and 29, and 21.7% were 30 or over; all of these respondents were biology and medical students. The participants varied in age from under 18–21, 22–25, and 26–29, and their education levels were as follows: there were 44 Diploma students, 146 High School pupils, 286 Undergraduates, 112 Graduates, and 24 Ph.D. candidates. According to the data, the respective percentages are 23.9, 18.3, and 3.9.

Cronbach's alpha is a useful measure of internal consistency for use with Likert-type scales in research [31]. Table 2 shows variable 216 and the overall reliability of the 215 New Media and Higher Education scores. The scale has a high level of internal consistency, as shown by the Cronbach's alpha of above 0.931 across all measures. In addition, as shown in Table 2, the alpha 219 value for all Cronbach's Animation virtual reality and university-level education aspects is 0.931, corresponding to 220, which is the most excellent attainable value. An Educational App for Virtual Reality (VRE) the reliability estimates for the VRE—Virtual Reality Education app; VR—Virtual Reality attention (221); VRR—Virtual Reality relevance (222); ARCS—Virtual Reality confidence (222); VRS—Virtual Reality satisfaction (223); and VRRHE—Virtual Reality and higher education (224) measures are 0.771, 0.775, 0.697, 0.779, and 0.683, respectively.

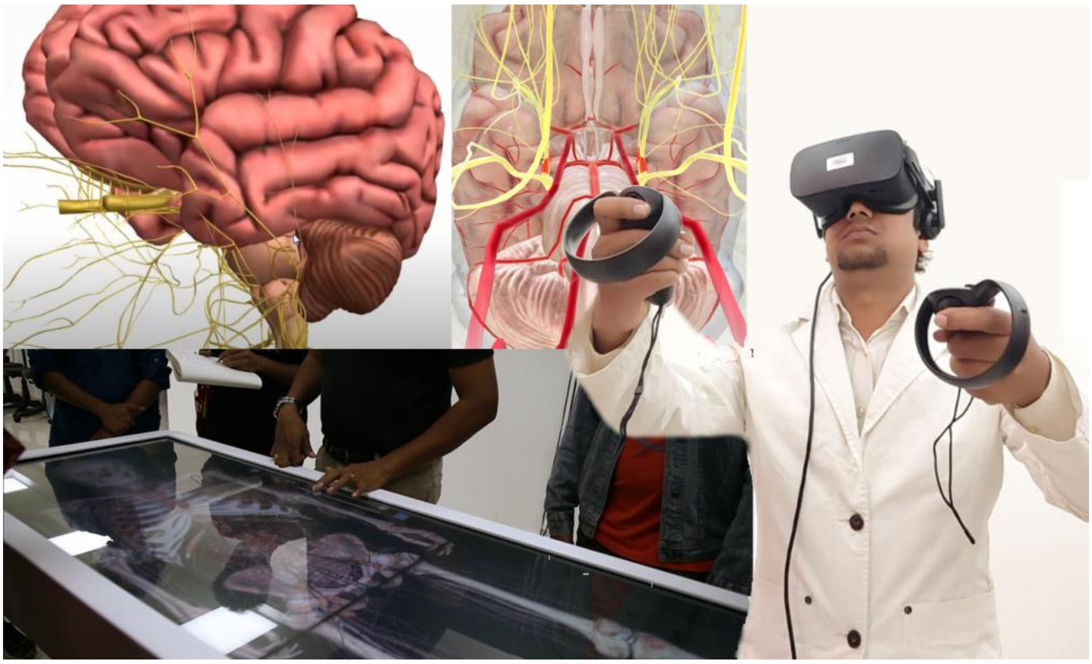

Figure 3. Immersive-AIoMT technology for teaching human anatomy.

Table 1. Demographic profiles of the respondents (n = 612).

Characteristics	Categories	Number of Respondents	Percentage (%)
Below 18		37	6
18–21		263	43
Age	22–25	131	21.4
26–29		48	7.8
30 above		133	21.7
Female		158	25.8
Gender	Male	453	74
Other		1	.2
Diploma		44	7.43
Education	Higher Secondary	146	23.9
Qualification	UG	286	46.7
PG		112	18.3
PhD		24	3.9

Table 2. Analysis of the impact of a Virtual Reality App on Higher Education.

Dimensions	Number of Attributes	Cronbach's Alpha
VRE	5.0	0.7712
VRA	5.0	0.7752
VRR	5.0	0.6972
VRC	5.0	0.77922
VRS	5.0	0.7712
VRR_HE	5.0	0.6832

Spearman's rho correlation was used to determine whether there was a connection between the use of a VR app and the pupil's concentration. Nearly three-quarters (72.3%) of the students said that the VR software improved their focus on the material, especially with respect to the central idea being taught. According to the ARCS model [32] hypothesis, the use of VR in the classroom is a great way to pique students' interest in the material being taught. Student's attention to the virtual reality app has a correlation value of 0.723, as seen in Table 3.

Table 3. Spearman's rho Correlations between the Virtual reality app and Students' Attention.

Correlations between the Virtual Reality App and Students' Attention			
		Virtual Reality Education App	**Virtual Reality Attention**
VR Education App	Correlation Coefficient	1.000	0.723 **
	Sig. (2-tailed)	0.000	0.000
Relevance	Correlation Coefficient	0.723 **	1.000
	Sig. (2-tailed)	0.000	0.000

** Correlation is Significant at the 0.01 Level (2-Tailed).

Spearman's rho was used to analyze the correlation between students' levels of self-assurance and their use of a VR app. A total of 63.8% of students agree that using the VR software increases their knowledge and comfort with the material being taught. According to the ARCS model, using VR in the classroom is a great way to pique students' attention. Table 4 shows a 0.638 correlation between students' confidence levels and their use of a virtual reality app.

Table 4. Spearman's rho Correlations between the Virtual reality app and Student Confidence.

Correlations between the Virtual Reality App and Student's Confidence			
		Virtual Reality Education App	**Virtual Reality Confidence**
VR Education App	Correlation Coefficient	1.000	0.638 **
	Sig. (2-tailed)	0.012	0.000
Relevance	Correlation Coefficient	0.638 **	1.000
	Sig. (2-tailed)	0.000	0.012

** Correlation is Significant at the 0.01 Level (2-Tailed).

The association between the virtual reality application and students' satisfaction was 0.703, as determined by Spearman's rho correlations test. The virtual reality application's degree of association was 70.3%; particularly with respect to the simulator experience being taught. The correlation between the Virtual reality app and the Students' Satisfaction value is 0.703, as shown in Table 5. Since the p value is 0.000 its proof that there is a strong relation between the Virtual Reality App and Students' satisfaction.

Table 5. Spearman's rho Correlations between the Virtual reality app and Students' Satisfaction.

Correlations between the Virtual Reality App and Students' Satisfaction			
		Virtual Reality Education App	**Virtual Reality Satisfaction**
VR Education App	Correlation Coefficient	1.000	0.703 **
	Sig. (2-tailed)		0.000
Relevance	Correlation Coefficient	0.703 **	1.000
	Sig. (2-tailed)	0.000	

** Correlation is Significant at the 0.01 Level (2-Tailed).

The Spearman's rho Correlations test determined the association between the virtual reality application and students' relevance. The virtual reality application is accepted by 72% of students and aids their satisfaction with the subject, particularly with respect to the concept being taught. The use of virtual reality in teaching thereby garners more interest among students, according to the ARCS model theory. The correlation between the Virtual reality app and Student's Relevance value is 0.727, as shown in Table 6.

Table 6. Spearman's rho Correlations between the Virtual reality app and Students' Relevance.

Correlations between the Virtual Reality App and Students' Relevance			
		Virtual Reality Education App	**Virtual Reality Relevance**
VR Education App	Correlation Coefficient	1.000	0.727 **
	Sig. (2-tailed)		0.000
Relevance	Correlation Coefficient	0.727 **	1.000
	Sig. (2-tailed)	0.012	0.012

** Correlation is Significant at the 0.01 Level (2-Tailed).

Table 7 represents the impact of Virtual Reality application with reference to the ARCS model—One-Sample *t*-test. Figure 4 shows the effects of virtual reality on higher education, and the one-sample *t*-test shows that 95.7% of these effects are positive. The study's findings also demonstrate that when the ARCS model is used, the majority of respondents (89.8%) believe that virtual reality sharpens their focus on the topic, 82.5% believe it boosts their confidence in it, 88% believe the content in VR applications is pertinent to the topic, and 82.8% say they are satisfied with using VR software. The study suggests a need to integrate the most effective teaching methods into virtual reality education and provides guidelines for developing new educational technologies that consider how children learn. It also encourages collaboration between developers and educators to ensure that virtual environments support children's agency and diversity in terms of representation and access.

Table 7. Impact of Virtual Reality application regarding ARCS model—One-Sample *t*-Test.

Reality Application Regarding ARCS Model—One-Sample *t*-Test			
Virtual Reality	**Test Value = 3**		
Education App	**t**	**df**	**Sig. (2-Tailed)**
VRE_IOT	81.218	263	0.000
VRA_IOT	89.848	263	0.000
VRR_IOT	88.015	263	0.000
VRS_IOT	82.862	263	0.000
VRC_IOT	82.531	263	0.000
VR_IOT_IMPAC	95.77	263	0.000

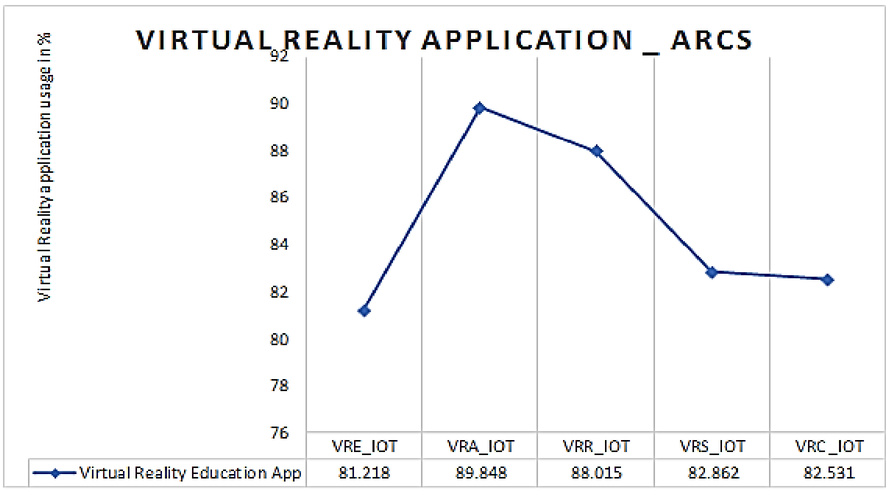

Figure 4. Impact of Virtual Reality application with respect to the ARCS model.

4.1. Q-Q Plot Analysis: Impact of Virtual Reality on Higher Education

Analyzing graphical data is a crucial first step in comprehending a statistical issue. Despite appearing to be straightforward, and the fact that numerous authors have authored in-depth articles about designing compelling statistical graphics [33], it frequently occurs that a graphic gives the wrong impression and causes the information it contains to be misinterpreted. The Q-Q plot is a popular tool for analyzing the goodness-of-fit of sample data with respect to a theoretical distribution. It enables the user to contrast a theoretical model, represented by a 45° slope line, with an empirical quantile function represented by all sample points. The Q-Q plot, however, has several flaws. First, sample variance might occasionally make it difficult to understand the plot, particularly regarding the behavior in the tails. According to the Q-Q Plot Analysis Impact of Virtual Reality on Higher Education, the above graph shows that the data were represented as a standard data distribution. This is demonstrated by the Animation Virtual Reality program, which positively affects higher education by supporting learning and the "ARSC Model". Figure 5 shows all the data points compared to a line; this demonstrates how significantly higher education levels are impacted positively.

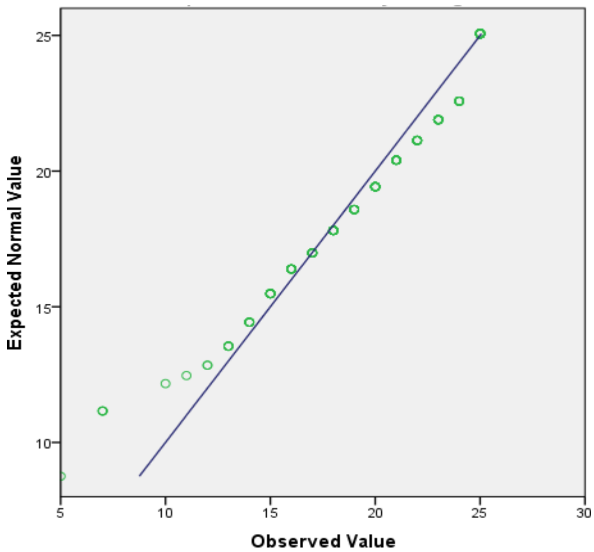

Figure 5. Q-Q Plot Analysis of the Impact of Virtual Reality on Higher Education.

4.2. Hypothesis

The proposed model is assumed to be a good fit, which constitutes the H0 hypothesis states that the suggested model does not fit well enough. The alternative hypothesis stated that the suggested model fit well.

To determine how well the model fits the data, structural equation modeling (SEM) was employed. The survey instrument's structural model was validated using AMOS version 23 per Anderson and Gerbing's suggestions for ensuring reliability and validity in the year1988. Structural equation modeling (SEM) helps check whether a model is consistent with a data set and determine whether a causal relationship exists between variables.

Table 8's chi-square/df score of 2.2521 is less than 5.00, indicating a good correlation between the two variables. Confirmatory Factor Analysis (CFA) and the Normed Fit Index were used to evaluate the data instead of the chi-square test. When the value is 0.9981 close to 1, the two entities match perfectly. The model is of very high quality with a PCLOSE of 0.0001, which is much below the acceptance threshold of 0.005, and an RMSEA of 0.07. Since the model fit values perfectly match with the recommended values as shown in Table 8, hence H_0 is rejected and alternative hypothesis is accepted.

Table 8. Summary of the model fit for the Structural Equation Model.

Model Fit Indices	Output/Result	Recommended Values
p value	0.1321	*p*-value > 0.05
Chi-square/degree of freedom (x2/d.f.)	2.2521	≤5.00
Comparative Fit index (CFI)	0.9991	>0.90
RMSEA	0.0701	>0.06 to 0.08 with the confidence interval
PCFI	0.0671	Sensitive to model size
NFI	0.9981	≤1(Values close to 1 indicate a very good fit)
PCLOSE	0.0001	<0.5

Figures 6 and 7 show the results. To recap, VRE IOT refers to the Virtual Reality Education Application; VRA IOT means VR awareness; VRR IOT means VR relevance; VRC IOT means VR confidence; VRS IOT means VR satisfaction; and ICT IMPACT VR refers to the impact of VR on higher education.

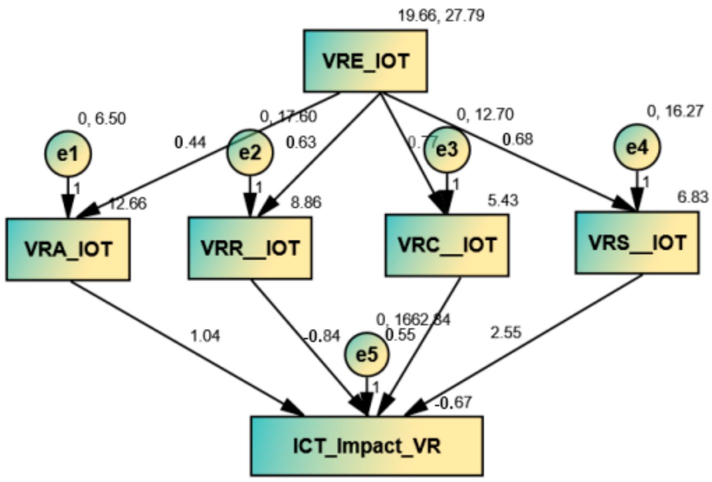

Figure 6. Unstandardized Estimate.

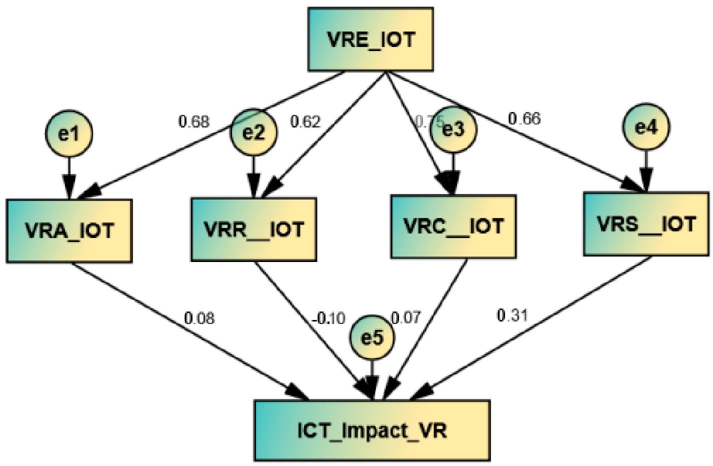

Figure 7. Standardized Estimate.

4.3. Important Parameter-Specific Tests

Standardized coefficients and test results are shown in Tables 9 and 10. When the standard regression coefficient of the dependent or mediating variable increases by one unit, the standard regression coefficient of the predicted variable also increases by one unit. Figure 6 depicts the standard deviation, and standard error estimates. Column P indicates the probability that the experiment was a complete failure under the null hypothesis and is labeled "Critical Ratio" (also known as the Critical Ratio, abbreviated as C.R.).

Table 9. Regression Weights: Maximum Likelihood Estimates.

Independent	Relationship	Dependent	Estimate	S.E.	C.R.	*p*
VRA_IOT	<—	VRE_IOT	0.443	0.020	22.615	
VRR IOT	<—	VRE_IOT	0.633	0.032	19.647	
VRC IOT	<—	VRE_IOT	0.772	0.027	28.234	
VRS IOT	<—	VRE_IOT	0.680	0.031	21.963	
ICT_Impact_VR	<—	VRA_IOT	1.038	0.585	1.775	0.076
ICT_Impact_VR	<—	VRR IOT	−0.839	0.365	−2.297	0.022
ICT_Impact_VR	<—	VRC IOT	0.554	0.391	1.417	0.156
ICT_Impact_VR	<—	VRS IOT	2.553	0.372	6.865	

Table 10. Standardized Regression Weights: Maximum Likelihood Estimates.

Independent	Relationship	Dependent	Estimate
VRA_IOT	<—	VRE_IOT	0.675
VRR IOT	<—	VRE_IOT	0.623
VRC IOT	<—	VRE_IOT	0.752
VRS IOT	<—	VRE_IOT	0.664
ICT_Impact_VR	<—	VRA_IOT	0.082
ICT_Impact_VR	<—	VRR IOT	0.103
ICT_Impact_VR	<—	VRC IOT	0.069
ICT_Impact_VR	<—	VRS IOT	0.315

The predictions were made using the model's statistical analysis. Uniform equations may be used to determine the relative contribution of each predictor to each outcome.

Table 11 shows that students clearly paid close attention, which increased their self-assurance and ability to grasp complex IT ideas. Furthermore, they had higher levels of enjoyment during the Cross Question game process, which contributed to enhancing learning outcomes. The findings of this investigation diverge sharply from those of Kwon and Ozpolat [34]. According to the results of their research, gamifying assessment tasks dramatically reduces students' comprehension of a topic, contentment, and course experience. In addition, the gamified group's team test scores were much lower than the individual exam scores across a variety of different measures.

Table 11. Comparative analysis with proposed model.

	Non-Gamified Classroom [26]	**Gamified Classroom (*n* = 44) [26]**	**Proposed Work (*n* = 126)**
	Mean	Mean	Mean
Confidence	2.9	4.4	4.8
Attention	2.9	4.6	4.6
Relevance	3.2	4.5	4.6
Satisfaction	3.25	4.4	4.58
Overall average	3.1	4.45	4.645
Cronbach's alpha	0.86	0.92	0.931

The ARCS model of Learning Motivational Dimensions was used to analyze virtual reality's effect on universities. Six hundred and twelve students conducted confirmatory factor analyses of thirty questions to determine the impact of a Virtual Reality application on higher education using the ARCS model to enhance the learning motivation dimensions. The ARCS model of learning motivation dimensions was used to choose the questions for this part of the analysis of the impact of a virtual reality application on higher education. The significance of virtual reality (VR) courses in today's classrooms cannot be overstated.

5. Conclusions and Future Work

Using the ARCS model of learning motivation variables, this research investigates the efficacy of VR applications in higher education. These findings point to the promising future of virtual reality (VR) technology in academic settings and the numerous opportunities for further development. Based on the results, it seems that biology students and medical practitioners can benefit from utilizing virtual reality as a learning platform since it facilitates more active engagement with the material being studied. VR technology does not restrict the ability of teachers and students to use multimedia-based teaching approaches, and they also call for collaboration between educators and industry leaders to determine the best ways to implement VR technology in the classroom. To better equip educators to take advantage of virtual reality, we must find the optimal method of integrating new media into higher education. Teachers and corporate leaders must work together to determine the best way to include these aspects in their curriculum. The actual cost of implementation may be more than anticipated because of insufficient school-level financing. There is still a long way to go before virtual reality reaches its full potential in education, but it is now a valuable tool that provides numerous alternatives. When introducing VR technology into the classroom, teachers should be careful not to restrict the range of teaching strategies available to students and teachers. The full potential of incorporating new media, virtual reality, and AIoMT into higher education cannot be reached without first increasing faculty members' skills in this new era of technology. The limitation of this model is that the participant of the study belongs to biology and medical students. The challenge in VR simulation based study as in the first few weeks of class students are excited to learn using simulators, but gradually the interest of the students learning with the simulators decreased, while some students do not take their studies seriously, as result it's challenge for the teachers to identify learner's engagement due to close VR head mounted display. We intend to integrate this model at various levels in the future, which may develop the attention of non-serious students. Using IoT and eye sensors integrated with pupil movements may vary levels of cognitive capacity and increase students' focus on learning.

Author Contributions: Conceptualization: A.K. (Abhishek Kumar) and A.K. (Ankit Kumar); Methodology, A.K.J.S., A.K. (Ankit Kumar) and B.S.; Software, A.K. (Abhishek Kumar), M.A. and A.K. (Ankit Kumar); Validation, M.A. and A.K. (Ankit Kumar); Formal analysis, A.K. (Abhishek Kumar), M.A. and B.S.; Investigation, A.K. (Abhishek Kumar), M.A., Z.H.A. and B.S.; Resources, M.A., B.A., M.H.A.H. and Z.H.A.; Data curation, B.A., M.B.K. and M.H.A.H.; Writing—original draft, A.K. (Abhishek Kumar); Writing—review & editing, A.K. (Abhishek Kumar) and B.S.; Visualization, B.A., M.B.K., A.K. (Ankit Kumar) and B.S.; Supervision, A.K.J.S.; Project administration, A.K.J.S.; Funding acquisition, A.K.J.S. All authors have read and agreed to the published version of the manuscript.

Funding: The authors thank the Deanship of Scientific Research at Imam Mohammad Ibn Saud Islamic University for funding this work through Research Group no. RG-21-07-02.

Data Availability Statement: Available upon request.

Acknowledgments: The authors extend their appreciation to the Deanship of Scientific Research at Imam Mohammad Ibn Saud Islamic University for funding this work through Research Group no. RG-21-07-02.

Conflicts of Interest: The authors declare no conflict of interest.

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