JCBI
Journal of Computing & Biomedical Informatics
ISSN: 2710 - 1606
Volume 05 Issue 02
2023

Review Article
https://doi.org/10.56979/502/2023

The Impact of Virtual Reality on Healthcare: A Comprehensive Study

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Received: July 25, 2023 **Accepted:** August 21, 2023 **Published:** September 17, 2023.

Abstract: Virtual Reality plays vital role in the field of medicine. This paper highlights the existing research issues and progressive tools which are related to the enlargement of efficient and workable virtual environment in health care. The organization of health care workers' education and learning is being greatly impacted by ongoing changes in the delivery of healthcare. Virtual reality is thought to be a significant field with great potential for improving healthcare professional training. Because the learning process can be established within a practical framework, virtual reality training can offer a successful, interactive, appealing, and engaging educational framework, supporting empirical learning-by-doing. In fact, it can contribute to elevating attention and enthusiasm in learners and effectively supporting skill acquisition. In today's advanced world it is recognized that medical awareness doubles after a couple of years, with novel medical methods emerging with passage of time.The main goal of this monograph is to discuss the fundamental benefits of using virtual environments for learning and teaching in the healthcare industry.Noteworthystudies and further related work done in this area is discussed as well, along with main problems regarding existing limitations and future directions.

Keywords: Virtual reality, Health care, Medical studies.

1. Introduction

The structure of the learning of health care professionals is being significantly impacted by incremental changes in health care delivery in a number of ways. As Kaufman emphasizes, "medicine has gone through major changes over the last 50 years. In today's modern world it is renowned that a medicinal fact increments every 6–8 years, with novel medical measures emerging day by day" [1].

Although medical information has a fairly short half-life, the average doctor stays in practice for 30 years, and the average nurse works for 40 years [2]. As a result, the main problem that must be overcome is deemed education. This has the effect of changing the curriculum, how employees are trained, how performance is evaluated, and how the faculty is organized within the educational system. According to Gorman, the 100-year-old apprenticeship model, best typified by the phase-in process, still dominates the education of these health care workers, both current and future. "See one, do one, teach one" [2].

In addition to a few brief instances of factual development of knowledge, for years lessons and pictures have created with the help of medical learning and training [3]. Modern progresses in instructive and teaching tools are offering growing number of inventive and powerful tools and model for training and learning process. There are Virtual worlds in two dimensions and three dimensions, as well as computer simulations, which may give a chance to improve the learning and understanding of learners and trainees through their familiarity with the virtual environments.

Bonk and few of his co-workers highlights, topical scientific and empirical enlargement and progress that have congregated to significantly make changes in commencement of educating and training method [4]. According to various proponents, virtual reality is a major field with enormous potential for expanding and changing learning practices. It can offer an active, dynamic learning environment that fosters practical knowledge [5][7]. Bruner stresses that carrying out the assignment in order to enhance the teaching and learning process [8].

Commonly health training and specifically medical procedure are constantly based on learning the presumptions are attained through direct interaction of learners with the patients. Technical advancement and development in education and training method is progressive but ultimately this process ascending a new phase in this process that is called “simulation”.

Simulation, which is also known as imitation, attained competence and endowment in the 1930s with the adoration of the first flight simulator, known as the "Link Trainer," and was deemed a method of erudition. People involved in the process of training health quickly became interested in the idea of teaching in a simulated environment, but at the time, no significant technological advancements were both practicable and practical.

The first simulator acquired considerable popularity and is considered the most notorious simulator, which was designed and accepted at the beginning of the 1960s by its developer, smund Laerdal. His simulator was a model created to provide guidance for mouth-to-mouth resuscitation; it became known as "Resusci Anne." It was so successful that the idea survived for decades, eventually reaching the present day with a wide spectrum of advancement that permits effective training to deal with cardio-respiratory arrest. [37].

Virtual Reality is increasingly enlarged simple tasks of learning and training to the acquisition of complex tasks, which may involve structuring of complex spaces of data, mental picture, prophecy and elucidation of theoretical tasks [9].

This paper addresses the underlying principle and focal advantages of virtual environments in medical training and learning. Significant research and smaller projects are also elaborated in this sector, along with the main and important issues pertaining current challenges and progressive directions in near and distant future.

2. Background

History of health care professionals in virtual reality environments in the field of computer sciences commenced with the hypothetical application for the usage of graphical model which was known as “sketchpad”, which was developed by Ivan Sutherland in 1960.While on the other hand, novelty in this specific area merely started with the motive of abundance of desktop computers and other basic components including peripherals in 1980.

With the incremental advancement in 1989 few workers of National Aeronautics and Space Administration introduced a tool which was recognized as foremost PC based simulator used for surgery and other training purposes, through which simulation usage for numerous methods of orthopaedics can be achieved, likewise biomechanical penalties of such methods can be deliberated on the desktop computer [38].

The previous studies regarding virtual environments for training health care professionals depicts that practical and efficient models are helpful for the learning of cardiopulmonary revival, vascular disease repair, incision and laparotomy surgeries, apprehension and anxiety process and strategies of midwifery and dentistry, gastro-copy and orthopaedic surgery, and so on.

Besides all these studies elaborating various methods, like the findings of Savata [39], that reported efficient use of virtual models for allopathic learning, few other researches with the objective to describe actual effect and influence of training on the learners i.e. the survey of Grantcharov et al.[40], who investigated how simulation in virtual environments helpful in rectification of tenant medical practitioner’s aptitude of erudition of appendectomy with the help of video surgical operation.

3. Advantage of Virtual Reality in Healthcare

Description of virtual reality given by Gaddis is: “a simulation created by computer of the existent or illusory situation or environment” [5].Fitzgerald and Riva said that the origin for the Virtual Reality design

is that a PC can amalgamate a three-dimensional graphical environment from statistical figures and facts [11]. With the use of optical and aural output devices, the user could be able to get feeling of part of the environment.

A central feature of virtual environment is to interact with the environment that is created for experiencing virtual world in an effective manner, which is possible with the use of peripheral data entry devices (mouse, joystick or common VR inputs such as Data glove), as a result of the user's motions, movements, and interactions.

As said by Winn, VR made possible opportunity for learners with the valid additional assessment, by possible way of interface and immersive systems where user becomes part of environment, to find out through first-person familiarity [5]. First-person practices considered vital for actions in the environment and understanding concerning it, assumed environments concede fabricating information from undeviating familiarity by giving the user the ability to recognize the fantasy and delusion of non-intervention between the user and the computer [12].

The probabilities and potentials possible by using virtual environments, for example 3D engrossment and engagement of user with the environment, numerous perceptions and multi-receptive signals provides many probable benefits of medical training and learning [13][14]:

3.1 Training and experience

Because interaction is necessary for learning in a virtual world, VR offers users the chance to practice and grasp new technologies through practical use. This encourages active engagement over passive participation. When students and trainees feel free to move and participate in self-governing tasks within their learning and training framework, learning is incorporated more effectively and productively.

Discovering and structuring content as an individual, they put in logical exertion for the framework of conceptual models which are stable and invariable with what is erudite earlier and with the accomplished advanced content. As stated by McGuire, This engaging activity provides students with a means of becoming acquainted with the world, through a “fragmentary way of building sense out of novel knowledge by generating their own version of reality world rather than merely understanding author’s observation” [15].

3.2 Hallucination

Environmental simulation can be utilized as an alternative presentation approach for things, as well as an inventive methodology and an effective visualization method. It is useful when information needs to be manipulated and reorganized using graphical symbols for the purpose of data visualization. It is also useful when it is necessary to make the undetectable visible.

3.3 Unattainable Real-life experience learning

Virtual reality makes it feasible to monitor and investigate situations and occurrences that are either unavailable or impractical to do so in traditional methods. Besides this, it allows tremendous and acute close assessment of an object, along with observation from large distance.

3.4 Enlargement of stimulus

Interacting with the model and environment of virtual reality can be more intriguing and attention-grabbing than doing so with actual objects, such as when playing a game. For instance, when working with uninteresting objects, it might be deemed a better resolution to make learning more motivating, engaging, and enjoyable.

3.5 Mutual fostering

Mutual VR can support the teamwork and promote the acquisition of abilities that can be used developed effectively with the help of collaborative experiences in a general setting. It is considered as importantly useful when there is a familiarity of creation of objects.

3.6 Flexibility

VR training provides the opportunities and options to be augmented to the needs and features of the learner. Learners are permitted to carry on with the practice at their personal level, and through the broad span of time not fixed by a standard class schedule. Moreover, VEs that are well deliberated can amenably present learners effective experiences that are more insightful than those that are typical of the "standard" teaching and learning process.

3.7 Analysis and Review

A variety of highly efficient and potential tools are offered by virtual environment and best tools for evaluation purpose are considered, in the view of the fact it is note-able that every conclave effortlessly examined and recorded by learners and teachers, as a result helpful and beneficial for the tasks of evaluation [20].

4. Application in Biomedical Education

Numerous VR systems have been invented, constructed, and put into use in the contemporary era to support training and education in a variety of academic and learning fields. There are many ways that virtual reality learning can be used as a legitimate supplement to traditional education. However, understanding how to use and adapt virtual reality to support the learning of various concepts and skills has presented a challenge for both educators and developers [37].

Other appealing and motivating applications involve the creation of 3D environments of virtual reality where user becomes part of virtual environment utilizing auditory and visual hallucinations to increase therapists' indulgence about the illness is a method used to train psychiatrists and psychologists in the treatment of schizophrenia [38].

4.1 Surgical education

Sativa and Jones described an achievable classification of virtual reality in health care training which is based on relevant purpose and notable individual learning, medicinal emergency teaching, and health care practical prototyping and modeling [21].Individual training systems are currently the majority of VR medical applications, claim the authors.

These particular tasks that are specifically confined for health care learning, which are also considered as partial learners, pursued to prepare a single or little set of expertise within a simulated world that is greatly practical and anatomically accurate. Kaufman and Bell defined the latent on the basis of virtual environment partial trainers for training and evaluating experimental skills of particular tasks [1]. It is a significant subject that is being studied by academics in a variety of therapeutic and scientific fields.

4.2 Disaster training systems

Healthcare tragedy training systems focus on difficult practices where one gets familiar with the environment instantly and commonly where response to an activity could be very trivial and restricted for example change in skin texture. Likewise, there is a need of enlargement and performance of few simulated ways, forgeries and interactions; from the augmentation of clinically sensible virtual patients to the support of dispersed and diffused systems for exalted-congruity imitation, and perhaps most importantly, to the invention of approaches created user performance realistically and practically on the virtual reality. Stansfield and his co-workers created Bio-Simmer, a completely immersive dispersed virtual world model created with the aim to instruct health care disaster-response personnel [6]. Small and his group offered an urgent situation medical simulator same as a flying simulator: a movable model with realistic features that represent the patient, which users manipulate with the aid of physical instruments that connect the model to a computer-controlled system that generates the appropriate medical position and response[22].

4.3 Virtual reality education for cerebral illness

At the 155th Annual Meeting of the American Psychiatric Association, a fascinating VR teaching application was recently presented, allowing guests to see what goes on in a person with schizophrenia's brain. Users are placed on a city bus in the actual and realistic virtual reality exercise, which surrounds them with the sights and noises that someone with schizophrenia would see and hear.

The simulator was developed by Janssen LP to teach clinicians, including psychiatrists, what it's like to suffer from a severe illness. In order to give participants the feeling of entering the world of schizophrenia, the experience, known as "The Bus Ride," employs specially synchronized sound and video footage that is transmitted on a wraparound screen in a mock bus.

The method was developed using reports of auditory and visual hallucinations that were given by patients and their doctors.

4.4 VE based Training and medical patient alliance

According to Letterie, Virtual world is considered successful for simulating and exhilarating person-to-person communication learning purpose in psychotherapy and contributes much in other sciences in a wide variety of conditions by actual simulations for delicate interactions, and to instigate three-dimensional learning mechanisms for health care imitation and simulation[22].This depicts that VR may be

helpful for developing a complex and multifaceted set of skills, including delicate facets of patient care, in addition to supporting the acquisition of practical and technology skills. The author places particular emphasis on the practical and workable application of virtual reality (VR) as a learning modality in obstetrics and gynaecology, which may be used to teach the fundamentals of counselling and therapy as well as surgical skill acquisition.

4.5 MIST system

MIST stands for Minimally Invasive Surgical Training system, which is an invention for laparoscopic procedures to achieve learning, training, and estimating in surgery. It was formerly developed in the United Kingdom and is now commercially available from Mantic Healthcare Training Impersonation AB in Gothenburg, Sweden[23].Virtual reality software package is useful and linked with equations of individual's perception and motor recital developed from practical psychology researches[24][25].

5. Technical Hazards

Usually there is a less knowledge of computing erudition of field of medicine, but computing apprehension, nervousness and enmity are genuine and veritable question [26] and primary care experts above the time of thirty are considered as the "forfeited generation" with respect to technical information [27].

NHS is putting high efforts for promotion of health library science and information study to medical professionals and introducing authorization of Britain functionality driving, which is going to become basis for future career including computing informatics [28].

Holistic and abundant admittance simulated operations, likewise usage of laparoscopy method videos becomes source of vanquishing number of inclination and leaning of surgery, but on the other hand virtual world and machine automation are considered as contraption or eventually hazardous by maximum medical professional [40]. More interdisciplinary collaboration will be necessary for the development of new surgical techniques and sciences. As progressive technologies are introducing in health care with passage of time, these innovative techniques are becoming source of increment in costs, besides which are obligatory to latent for enhanced clinical proficiency and condensed medicinal flaws, with abridged ailment and mortality. Verification for these reimbursements is expected to take at least 5-10 years to mount up.

6. Conclusions

Technical improvement and enhancement have made possible for medical trainers to access a wide range of novel learning tools.Besides this, virtual reality is considered as an enormous latent in order to improve the training process [9][13].

At the outset, VR offers sophisticated interaction with the learning content, it can encourage active and genuine involvement by students and trainees. VEs can offer experimental and practical approaches of learning. This enhances situations that are thought to be crucial to the learning process, such as motivation, encouragement, curiosity, and awareness. Additionally, VR education enables entirely new abilities and practices that are either too expensive, too hard, or just plain impossible and impractical to use in the actual world. Finally, individual learning styles and presentation styles can be adjusted in VR situations. They are incredibly adaptable and programmable, allowing the instructor or trainer to offer a variety of controlled stimuli and assess a wide range of user responses.

The investigated VR systems differ significantly in terms of several technical factors, including hardware and software configuration, interaction modes, Internet use, support for single- and multi-user interaction, and multimedia technology components embedded in 3D settings [39]. A few VR features that are beneficial to education and training include levels of engagement and captivation, vivid reliability and interactivity, multisensory cues, the possibility of teamwork, number and convolution of tasks supported, and multisensory cues. These features depend heavily on the calibre and expertise of the VE device. In actuality, a training environment's characteristics don't act in isolation and segregation.

The essential components, which include the concepts to be understood, common features, training understanding capacity, and communication practice, all play an important role in determining the learning method, training and learning results, and teaching method. [9][36].

When considering the current use and integration of VR technologies in learning and training environments, it is easy to see how a number of issues limit their clear and actual application and usefulness.

These concerns, which encompass instructive, technical, practical, institutional, cultural, cost-effective, organization, and interface design issues, provide challenges for future work of learning VEs.

At the moment, costs are undoubtedly a substantial barrier to VR distribution in the learning context. Although some attempts have been made to use computer-based VR systems, the majority of active VEs are based on VR systems such as CAVEs or high-end platforms, the cost of which is beyond the grasp of the average university or health centre, let alone single students.

It should also be considered that the operation of VR training systems may be more expensive than using other standard teaching methods, necessitating continuing financial support.

Furthermore, practically all applications in this field are "one-off" creations linked to proprietary hardware and software that have been tweaked through a process of trial and error. As a result, they are difficult to apply in contexts other than those for which they were designed. Furthermore, a lack of reference principles extends beyond technical elements to a lack of general reference assistance in design, performance, valuation, estimation, and assessment.

Regarding changes to educational culture, 3-D graphics technology is not meant to fully replace traditional classroom teaching methods; however, as Dean and colleagues note, properly implemented virtual environments can be a valuable supplemental educational and learning resource to enhance and highlight traditional methods. To effectively assist learning practice in 3D worlds, teachers must develop specialized knowledge and adequate realistic VR learning experience.

Finally, the system's usability is portrayed as being crucial; nevertheless, given the complexity of the learning environment and the cutting-edge VR technology, this is undoubtedly not a simple feat. The importance of including end users in the development of computer technology throughout the design stage is emphasized by interface professionals. Additional research is needed, both on the technological side and in regards to VR-related concerns like learning transfer, appropriate curriculum implementation, basics of effective VR design, and the psychosomatic and sociological effects of technology use.

7. Future Directions

Apart from the increasing progress of existing applications, virtual reality also most likely engaged in such interesting evolution as surgical process and nanosurgery.

Just like the beginning of simulation virtual reality was progressed to monitor macro-scale automated machines for use in haphazard environment, forthcoming small automated machines and robots even nanobots, for instance the DNA "screw driver,"[29] developed for exploitation in the individual's body and regulation by specialist operational worker with novel virtual reality equipment will be needed.

Formerly, a "small-submarine" powered by a tiny training motor to throw in a syringe needle and has the ability for numerous diagnostic purposes or curative functionality, has produced by German association [30]. Tiny cameras are used for examining process for a number of diseases that can be ingested and pass imagery of the epithelial duct centerfield to a performance location [31][32].

Funding: This research received no external funding.

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

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