Original article

DIGITAL TRANSFORMATION OF THE MEDICAL EDUCATION

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ABSTRACT:

Introduction: Digital transformation has drastically changed nearly every field of human life in the last couple of years. Education is not an exception. For many years changes in education have been happening at a very slow pace, but in the 21stcentury, this has changed. Some of the most important shifts in the field of medical education are related to the inclusion of AI and VR in the training of students.

Aim: The article aims to analyze some of the most important effects that digital transformation has on medical education.

Material and methods: The author used theoretical and practical scientific methods. Important and impactful articles related to the topic are analyzed.

Results: The results of the research undoubtedly show the great importance that innovative techniques, methods, and tools, created thanks to the digital transformation, have on medical education.

Conclusion: Medical students could benefit vastly from the inclusion of AI and VR in their curriculum. Thus, they will not only be eased in their daily work when they become doctors but they will be ready for the upcoming changes in the medical field as well.

Keywords: medical education, innovation, digital transformation, artificial intelligence (AI), virtual reality (VR),

INTRODUCTION

One of the fields that has hardly changed its traditionalform in the years up to the 21st century is education. The training of medical specialists is no exception, as it follows established, traditionalmethods and norms – lectures and exercises with a teacher; knowledge verification with verbal and written exams and practicalsimulations. The reasons for this are multifaceted,the main ones are – the vitally important place that this sphere has in the life of every person, as well as the delayed time for the appearance of specific results (qualitatively and quantitatively evaluation)in case new approaches and training methods, are applied. The latter means that any change in the field requires a long time to be able researchers to analyze the benefits and negatives of their incorporation, therefore such changes can only be made in the presence of far-sighted strategic thinking and the matching of the policies of the various parties that will lead the country for at least ten, twenty or even more years. In addition, in order to transpose the particular change worldwide, it is necessary that a large number of countries in the world are convinced of the positive results that this concrete transformation will bring and decide to take the risk of implementing it. All this determines the absence of drastic changes in the commented area despite the First, Second and Third industrial revolutions.

According to leading economists, at the beginning of the 21st century, the rapid progress of the Fourth Industrial Revolution began, which led to drastic transformations in all spheres of human life. One of the most prominent economists, the founder of the World Economic Forum, Klaus Schwab in his publication on "Foreign Affairs", shares that "The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now the Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres. Another important aspect of the ongoing industrial revolution, again according to Schwab, is the unprecedented rapidity of change [1]. In this line of thought, we can conclude that the world in the 21st century is facing an unprecedentedly fast-paced change in all spheres, therefore education and in particular medical education is also beginning its rapid transformation.

The object of the study is digital transformation.

The subject is the impact that digital transformation has on medical education.

The purpose of the research is to analyze some of the most important effects that digital transformation brings to education in the field of medicine.

The formulated author's hypothesis is – digital transformation leads to the creation and implementation of innovative teaching methods and tools that bring significant benefits to students.

The main task is conducting research related to two of the main innovations - AI and VR that are currently being implemented in medical education due to digital transformation.

Limitation of the research – only two of the most important innovations in the field of medical education created thanks to digital transformation are analyzed.

MATERIALS AND METHODS

To achieve the objectives of the research, the following practical and scientific methods were used:

- analysis and synthesis – the entire article is realized through the constant use of both methods, with a number of leading concepts being decomposed into their component parts and evaluated, and then comprehensive conclusions are drawn;

- induction and deduction - in the realization of the analysis, the author conducts his research both in the direction from the individual to the general, and vice versa;

- abstraction – for the purposes of the article, the author abstracts from a large number of other important innovations in education related to digital transformation and limits himself to only the most essential ones;

- summarization – the individual conclusions for specific objects are summarized so that general conclusions can be finalized;

- research documents, articles, studies, books, etc.

RESULTS AND DISCUSSION

The process of digital transformation accelerated after the beginning of the 21st century and drastically changed or started to change all spheres of human life. Education is no exception. Also, should be taken into consideration the fact that the pandemic caused by the COVID-19 virus also acted as a catalyst to speed up this transformation. Changes that individual companies, institutions, and even countries had planned to happen within a few years, because of the pandemic had to happen within months, and sometimes even weeks. It is the catalyzing effect that the pandemic had on digital transformation that can also be seen as one of the very few, perhaps even the only, positive aspects related to the pandemic. Because of the pandemic, in the field of education, it was necessary to happened changes in the way of learning extremely quickly. For example, moving to a remote form of learning, in order to guarantee the continuity of the learning process. In order to understand in depth the impact and main characteristics of the ongoing digital transformation in the field of medical education, it is necessary to briefly examine and analyze the transformation process itself.

After the middle of the twentieth century, the digitization process began to take place, which represents the first, fundamental step in the realization of the more complex concept of digital transformation. The sequence is as follows:

Fig. 1. Digital Transformation process.

According to modern theory, digitization, generally speaking, is a digital representation of a physical object, data, documents, photographic materials, etc. [2].

Digitization is used as a base, fundament on which complex processes of digitalization and digital transformation are happening. The latter two processes could not happen without digitization taking place first.

There are a number of different definitions of digitalization in academic circles, but in general, the term can be seen as the actual use of digitization in practice to be achieved certain result. In other words, digitalization is a process in which, as a result of the transformation of physical objects into various digital elements (e.g. software), the latter can be used much more productively and efficiently, and can help achieve new knowledge or create innovative products and services.

The third process – digital transformation, is the most complex one since the concept to a certain extent has an abstract meaning depending on the purposes for which it is used. In business, it represents a drastic change in the way of working, in the business plan, in the organisational processes, etc. In the state administration, the process is seen as increasing the intensity and efficiency in the work of administrative resources, and in the field of education as an opportunity to introduce innovative models and methods of training that can complement and sometimes even replace some of the traditional ones.

A significant number of new techniques and instruments as a result of digital transformation are already used in medical education worldwide. In this article, it is not possible to analyze all of them, for this reason, only two of the most significant changes have been researched - the introduction of artificial intelligence, as well as the use of virtual reality to simulate real situations.

According to a survey of more than 3,000 medical students in different countries, their main concern (amongst almost 50% of all respondents) related to the entry of AI into medicine is that it will lead to higher unemployment among medical staff [3]. It is important to note that AI is already actively used in medicine. According to IBM researchers, "the most common roles for AI in medical settings are clinical decision support and imaging analysis. Clinical decision support tools help providers make decisions about treatments, medications, mental health, and other patient needs by providing them with quick access to information or research that's relevant to their patient. In medical imaging, AI tools are being used to analyze CT scans, x-rays, MRIs and other images for

lesions or other findings that a human radiologist might miss"[4]. In this line of thinking, it is logical to assume that the use of AI in medicine will continue to grow in the future. One of the main ways to address students' concerns about job losses because of the implementation of AI in medicine is precisely to train medical professionals to work with AI. Several universities around the world have already introduced similar changes to their curricula to prepare their students for the future. The presented Figure 2 lists some of the universities that already implement such programs.

Fig. 2. Implemented AI Training [5]

Institution	Project
Duke Institute for Health Innovation	Medical students work together with data experts to develop care-enhanced technologies made for physicians
University of Florida	Radiology residents work with a technology-based company to develop computer-aided detection for mammography
Carle Illinois College of Medicine	Offers a course by a scientist, clinical scientist, and engineer to learn about new technologies
Sharon Lund Medical Intelligence and Innovation Institute	Organizes a summer course on all new technologies in health care, open to medical students
Stanford University Center for Artificial Intelligence in Medicine and Imaging	Involves graduate and postgraduate students in solving health care problems with the use of machine learning
University of Virginia Center for Engineering in Medicine	Involves medical students in the engineering labs to create innovative ideas in health care

The Medical University – Varna, also has already initiated the creation of two master programs related to the topic - AI in BioMedicin and AI in HealthCare [6]. This shows their foresight and pioneering in the field in Bulgaria.

The need to train medical professionals to work with AI also stems from the following several facts:

- Based on a specific research it was estimated that 70 years ago the time needed to be doubled the medical knowledge was approximately fifty years. In the late seventies the time was around seven years and in 2010 dropped further to less than three and a half years. Analyzes about 2020 show that the time has dropped even more to around seventy-three days. The same article concludes that medical students that began studying around the year of 2010 will face approximately three doublings in knowledge by the time they complete the minimum length of training (seven years) needed to practice this specialty. What was learned in the first 3 years of medical school will be just 6% of what is known at the end of the decade from 2010 to 2020 [7].

- The research shows that medical students would need to study more than 29 hours every weekday to keep up with the primary care literature [8].

- Today, 88% of internal medicine residents specialize, up from 7% in 1951–1960 [9].

The listed important data based on different articles shows the significant change in terms of knowledge that professionals had to have in the past and must have now, so it is important for them to be able to use tools that help, and AI provides these types of tools.

Simulations are another important aspect of medical education that is being dramatically changed because of digital transformation. The latter led to the rapid development of virtual reality, which provides a very close experience to the real world. Leading medical universities worldwide have in recent years implemented the use of virtual reality to conduct realistic simulations. This technology enables students to see and participate in all kinds of operations and situations. It is important that students are not only spectators but also active participants in these realistic simulations, being able to operate, assist, etc. An important fact is that the level of difficulty of the individual simulations can also be changed to get as close as possible experience to the real situation, which in turn provides a good starting point for gaining higher practical knowledge by the students. It is also important that "VR offers benefits both for learners and educators, delivering cost-effective, repeatable, standardized trainings". A significant amount of data proves that VR simulations should be used in all industries, including healthcare. Although VR is not a general solution for all problems in the education system, it is a powerful instrument and its importance is growing worldwide every year [10].

As leading researches state, VR is not a panacea, nor is AI, but both should be used to help medical staff in their preparedness and in their daily work. Numerous researches have been done related to the effect that VR has on medical education, and these are some of the results:

- "It has been suggested that the fidelity of the simulation might impact the cognitive and clinical skills of healthcare providers interacting with the simulation" [11, 12]

- "A high level of fidelity and realism is associated with effective learning [13] and is required by the National Council of State Boards of Nursing" [14]

- "The closer the realism is to clinical reality, the easier it is for participants to engage in the simulation scenario" [15].

All listed results of the implementation of VR in medical education undoubtedly show the great importance that this technology already has. We can only imagine what other benefits it will bring in the future as well.

CONCLUSION

Digital transformation has led to drastic changes in many areas and medical education is one of them. It is important to note that the process is not over, on the contrary, it is now beginning, and we are yet to witness innovative new tools that medical professionals will be able to use in their daily work. The main task set by the author of this article has been realized, analyzing concrete data on the benefits of implementing AI and VR in medical education. The author's hypothesis was also confirmed, according to which digital transformation has led to the creation and implementation of innovative teaching methods and tools that bring significant benefits to students in the medical field.

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