Anwendung von simulations-bildungstechnologien bei der kompetenzentwicklung von medizinstudierenden

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Abstrakt: Bevor sie an realen Patienten angewendet werden, sollten Ärzte praktische Fähigkeiten in der klinischen Arbeit in speziellen Zentren erwerben, die mit High-Tech-Simulatoren und computerisierten Mannequins, Computerspielen und Programmen ausgestattet sind, die es ermöglichen, klinische und organisatorische Situationen zu simulieren. Eine der wichtigen Voraussetzungen für die Umsetzung dieses Prinzips ist die Schaffung moderner Simulationszentren. Der Artikel diskutiert die Probleme, die für eine erfolgreiche und effektive Implementierung von Simulationstrainings in der medizinischen Berufsausbildung gelöst werden müssen.

Schlüsselwörter: Simulationstraining in der Medizin; Simulationstechnologien; Simulationszentrum; Simulationstraining; Simulationsmethoden; Aufbau praktischer Kompetenzen.

Application of simulation education technologies in competence development of medical students

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Abstract: Before applying them to real patients, doctors should acquire practical skills in clinical work in special centers equipped with high-tech simulators and computerized mannequins, computer games and programs that allow simulating clinical and organizational situations. One of the important prerequisites for the implementation of this principle is the creation of modern simulation centers. The article discusses the problems that need to be solved for a successful and effective implementation of simulation training in medical professional education.

Keywords: simulation training in medicine; simulation technologies; simulation center; simulation training; simulation methods; Building practical skills.

The rapid development of high-tech medicine in the modern world places increased demands on the quality of medical services. The quality of medical care and the quality of life of patients should underlie the assessment of both the professional activities of individual specialists and institutions, and the level of healthcare in general. There are 98,000 deaths per year in the United States due to medical errors [1]. There are no such official statistics for Uzbekistan, but the problem of forming the practical competencies of a doctor is also quite acute. Thus, according to a survey of medical school graduates in 2012, only 12% of them rate their knowledge of practical skills as good [2]. In addition, an insufficient level of development of non-technical skills (including teamwork, leadership, effective

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communication, level of knowledge and the ability to make the right decisions) are common causes of medical errors [3].

Obviously, modern medical education must also correspond to the ongoing technological revolution and changes in the surrounding information environment. High modern requirements for the development of practical skills by medical students, for updating the educational material and bringing the educational environment closer to the new environment of practical healthcare make virtual technologies in medical education a key direction in the development of higher medical school. The classical system of clinical medical education is not able to fully solve the problem of high-quality practical training of a doctor. The main obstacles to this are the lack of continuous feedback between the student and the teacher, the impossibility of practical illustration of the whole variety of clinical situations, as well as moral, ethical and legislative restrictions in the communication of students with the patient. Therefore, the key task of modern secondary, higher and postgraduate medical education is to create conditions for the development of a wide range of competencies and well-established practical skills among students without the risk of harming the patient. This includes the development of the ability to make quick decisions and perform flawlessly a number of manipulations or interventions, especially in emergency conditions [4]. It is obvious that the training of specialists responsible for the life and health of people in the modern world simply cannot be built without the most important simulation component. A lot of experience has already been accumulated, proving the effectiveness of simulation training.

Numerous evidences have been obtained indicating the successful transfer of the skills acquired by the doctor to the treatment of the patient [5], which could not but lead to the extensive development of a network of simulation centers. Thus, over the 5 years from 2003 to 2008 in the United States, the number of residencies has sharply increased, where simulation training of doctors specializing in emergency medicine is used. Thus, in 2003, simulation training existed in 33 (29%) residencies out of 134 respondents, and in 2008, in 114 (85%) [6].

Currently, there are various definitions of the concept of “simulation learning”. If we talk about this approach regardless of professional activity, then most often, simulation training is considered as a mandatory component in professional training, using a model of professional activity in order to provide each student with the opportunity to perform professional activity or its individual elements in accordance with professional standards and / or procedures (rules) [7]. Mc Gaghy (1999) describes a simulation as “a person, device, or set of conditions that authentically recreates a problem at hand. The student or trainee must respond to the situation that

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has arisen in the same way as he would do in real life" [8]. David Gaba of Stanford University has proposed a more detailed definition of this term, according to which a simulation is "a technique (not a technology) that allows you to replace or enrich the practical experience of the trainee with an artificially created situation that reflects and reproduces the problems that occur in the real world, in a fully interactive manner." Gaba also argued the need for planning in the organization of the educational process; he emphasized that simulation is primarily about learning, and not about the technology that underlies the simulation. Nicolas Maran and Ronnie Glavin of the Scottish Clinical Simulation Center described simulation as "an educational technique that involves an interactive, 'immersive' activity by recreating a real clinical picture in whole or in part, without any associated risk to the patient."

Thus, simulation is an imitation, modeling, a realistic reproduction of the process. In addition, simulation in medical education is a modern technology for teaching and evaluating practical skills, abilities and knowledge, based on realistic modeling, simulating a clinical situation or a single physiological system, for which biological, mechanical, electronic and virtual (computer) models can be used. Simulation training should be carried out by specially trained full-time instructors (teacher-trainers, training masters), who, together with practicing specialists (experts), will create and accumulate the baggage of various scenarios, conduct methodological work, and, together with technical workers (technicians and engineers), develop and maintain training facilities (software, computers, simulators, simulators, phantoms, models and professional equipment) in working and safe condition based on a system of engineering and maintenance and supply of consumables. One of the important stages of simulation training is debriefing. Debriefing (from the English debriefing - discussion after completing the task) - following the execution of the simulation exercise, its analysis, analysis of the "pluses" and "minuses" of the trainees' actions and discussion of the experience they have gained. This type of activity activates reflective thinking in trainees and provides feedback to assess the quality of the simulation task and consolidate the acquired skills and knowledge. Studies show that trainees have a limited understanding of what happens to them when they are involved in a simulation experience. Being in the center of events, they see only what can be seen from the point of view of the active participant [9]. Therefore, it is thanks to debriefing that the simulation experience turns into a conscious practice, which will ultimately help the trainee prepare both emotionally and physically for future professional activities.

According to G. Salvoldelli et al. conducting, a debriefing significantly increases the effectiveness of a simulation session on crisis situations in

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anesthesiology. In another study, it was found that the inclusion of debriefing in the simulation training of anesthesiologists increased the effectiveness of training, as well as the duration of retention of acquired knowledge and skills by cadets [10].

The history of the use of medical simulation in the education of doctors dates back many millennia and is inextricably linked with the development of medical knowledge and the progress of scientific and technological progress. Thus, the success of the chemical industry led to the emergence of plastic dummies, the progress of computer technology predetermined the creation of virtual simulators and patient simulators.

In the domestic healthcare system, among other things, various phantoms, models, dummies, simulators, virtual simulators and other technical training aids have appeared and are being widely introduced, which allow modeling processes, situations and other aspects of the professional activity of medical workers with varying degrees of reliability. At the same time, if individual phantoms for practicing the simplest practical skills have been used in some educational institutions for a long time, then the introduction of complex virtual simulators and management systems for their use in education appeared only in the last decade. To date, sufficient experience has been accumulated in the application of simulation methods in education, including medical education [11].

Doctors who begin their practical work need a long period to master the practical skills of performing various medical interventions. Thus, according to different authors, physicians specializing in endovideosurgery need to perform from 10 to 200 laparoscopic cholecystectomy, 20–60 fundoplication, etc. [12].

The traditional forms of teaching the practical skills of a doctor include the following options: on animals, on cadavers, with the participation of patients (assistance during curation and operations). All these training options have significant drawbacks - when training on animals, it is necessary to maintain and maintain a vivarium, pay for the work of its employees, and purchase animals; at the same time, the number and time of manipulations are limited, constant individual monitoring of the teacher with a subjective assessment of the work of the student is necessary, there are organizational problems in the use of drugs, it is necessary to take into account the protests of animal rights activists, ethical problems, etc. It is just as difficult and inconvenient to train on corpses, which requires the organization of a special service, while the work is unrealistic.

To achieve the proper level of practical skills, it is necessary to perform 100–200 procedures under the supervision of a teacher. These training options require expensive equipment, tool kits, and consumables and finally, due to the risk of harm

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to the patient, the risk of developing iatrogenic complications, the acquisition of initial, basic practical skills with the participation of patients should be considered unacceptable [13].

The only effective and safe way to develop practical skills is currently provided by virtual technologies. The situations simulated on the computer actively react to the actions of the cadets and completely imitate the physiological response of the patient to the actions of the doctor or reproduce the adequate response of the tissues to the manipulations of the surgeon. Doctors who have mastered practical skills with the help of virtual simulators move on to real interventions much faster and more confidently, their further real results become more professional. in addition, computer simulation based on objective data of a real patient (MRI, CT, ultrasound, etc.) makes it possible to predict in advance and even work out an upcoming examination or operation, which reduces the potential risk and improves the quality of medical care [14].

Training on robots - patient simulators allows you to assess the initial level of teamwork and significantly improve it in the learning process. A study conducted on simulators in the simulation of traumatic shock proved a significant increase in team skills during the training process [15]. At the same time, it is necessary to take into account the data of the study, which proved that the assimilation of CPR skills is higher on simulator robots than on simulators [16]. Currently, dozens of companies around the world produce virtual simulators for many medical specialties. Dozens of annual conferences are devoted to them; hundreds of articles are published [17]. Virtual simulators have a number of undoubted advantages over the training options discussed above - there are no current financial costs, the duration and mode of training are not limited in time, any number of repetitions of the exercise is possible with automatic, instant and impartial qualitative and quantitative assessment until its full proven mastery is achieved and consolidation, the constant presence of a teacher is not required, methodological recommendations are carried out automatically, the program itself indicates the mistakes made, and objective certification is performed. Already the first completed studies by N. Seymour show the benefits of virtual simulators. According to the authors, the use of a virtual simulator in the educational process significantly, by 2.5 times, reduces the number of mistakes that novice surgeons make when performing their first laparoscopic operations. The results of the research confirm the validity of the continued introduction of simulation virtual technologies in medical education and training programs. The realism of simulation equipment (fidelity) used to train health workers are divided into seven levels [18].

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When developing simulators, each subsequent level is more difficult to implement. According to these levels of realism, all simulators can be classified:

1. Visual, when traditional teaching technologies are used - diagrams, printed posters, models of the human anatomical structure. It can also be the simplest e-books and computer programs. The basis of any practical skill is visual simulation training, during which the correct sequence of actions is practiced when performing medical manipulations. The disadvantage is the lack of practical training of the trainee.

2. Tactile, when the passive reaction of the phantom is reproduced. In this case, manual skills, coordinated movements and their sequence are practiced. Thanks to realistic phantoms, it is possible to bring certain manipulations to automatism, to acquire technical skills in their implementation.

3. Reactive, when the simplest active reactions of the phantom to the student's actions are reproduced. Assessment of the accuracy of the actions of a trained person is carried out only at a basic level. Such dummies and simulators are made of plastic, supplemented by electronic controllers.

4. Automated - these are the reactions of the mannequin to external influences. Such simulators use computer technology based on scripts, when certain actions are given a specific response by a phantom. Cognitive skills and sensory motor skills are being developed.

5. Hardware - the situation of the medical office, operating room. Thanks to such training systems, a confident ability to act in a similar reality is achieved.

6. Interactive - complex interaction of the simulator mannequin with medical equipment and the cadet. Automatic change in the physiological state of an artificial patient, an adequate response to the introduction of drugs, to incorrect actions. At this level, the trainee's qualifications can be directly assessed.

7. Integrated - the interaction of simulators and medical devices. During the operation, virtual simulators demonstrate all the necessary indicators. psychomotor skills, sensorimotor skills of technical and non-technical skills are being worked out. The transition to the next level of realism will increase the cost of simulation equipment by a factor of three (the “triple rule”).

Separately, I would like to dwell on such a form of simulation training as a "standardized patient". A standardized patient is a person (usually an actor) who has been trained to simulate a disease or condition with a high degree of realism such that even an experienced clinician cannot recognize the simulation. Work with a "standardized patient" allows assessing the skills of taking an anamnesis, adherence to deontological principles and assessing the clinical thinking of a doctor.

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The use of actors instead of patients during practical training was first tested in 1963 by teachers at the University of Southern California while teaching medical students as part of a three-year neuroscience-training program. Actors trained to portray pathological conditions played the role of patients. A description of this experience was published in 1964, but then, half a century ago, the method was considered expensive and unscientific. Then in 1968 the practice of using assistants to demonstrate a gynecological examination was introduced. A more broadly similar covert integration of patient actors into the work of clinics occurred in the 1970s, during which there was a change in the name of "instructor patients" to "standardized patients."

In 1993, the Medical Council of Canada included for the first time the assessment of the skills of medical students using standardized patients in the licensing program, and the following year this method of assessing knowledge and skills was officially adopted by the educational commission for graduates of foreign medical institutions [19]. Scientific studies have proven the obvious effectiveness of simulation training compared to traditional [20].

The validity, reliability and practicality of the "practical clinical examination" has been confirmed and described in many studies, the data became the basis for the official approval of the National board of medical Examiners (NbmE) for the practice of using standardized patients in the IV-VII courses of study. The first mandatory testing of US medical students (clinical skills - stage II) was performed in 2004 as part of the state licensing program [21]. The practice of using a “standardized patient” also exists in the system of Russian medical education, however, due to the high cost and difficulty of organization, it has not received wide distribution [22].

For the effective application of simulation training, it is necessary to comply with the basic methodological and organizational principles [23]:

1. Integration of simulation training into the current system of vocational education at all levels.

2. The presence of a legislative framework that contains a rule on admission to work (training) with patients, as well as a list of mandatory competencies in specialties that require priority organization of simulation training. As a result, it should become the norm to prevent (remove) from training (work) with patients persons who have not passed certification using simulation methods in accordance with the list of competencies in their specialty (level of education). The legislative framework should be flexible and improved as this direction develops.

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3. Intensive organization of the educational process, modular construction of the simulation training program and opportunities for simultaneous training of different categories of medical personnel (by type and specialty).

4. Objectivity of certification based on approved standards (rules), for compliance with the criteria and with the documentation and video recording of the process and results of pedagogical control, during which the impact of the examiner's personality should tend to zero.

5. The presence of independent experts and observers during the state certification procedures is mandatory from among employers (professional societies), as well as two members of societies associated with the protection of patients' rights (each time changing).

6. A unified system for evaluating the results of simulation training (for all organizers using these simulation methods).

7. Availability of a system of state accounting for the results of passing the relevant modules of simulation training by specialists (registry of specialists).

8. Availability of a personnel training system (teachers, instructors) providing simulation training.

The pedagogical approach to creating a simulator has also become fundamentally new. The goal of simulation training is not only the acquisition of manual technical skills. The trainee must be aware of his presence in the medical environment, his inextricable connection with the operated patient, with his pathological condition. To do this, treatment cases are implemented in the form of tasks. The trainee is invited not only to perform technical actions, but also to assess the clinical situation, to make the right tactical decision. The actions of the simulator operator do not just change the virtual tissues, it worsens the condition of the virtual patient, provokes the development of complications in him, which will then have to be dealt with. This undoubtedly increases the realism of the simulation and the significance of such training in general.

It is proposed to divide the simulation certification centers into three levels:

I level - basic, regional significance; II level - leading, district significance; III level - the highest, federal value.

When dividing the centers into levels, some of the above criteria are considered basic or primary, and the rest are secondary, logically arising from the first. The main criteria are:

• The quality of the educational process, which is indirectly characterized by the qualifications of teachers, the equipment of the center, the innovativeness and effectiveness of the methods used.

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• Own methodological developments

• Conducting research, testing of medical equipment and other scientific work by the staff of the center.

• The number of publications on methodological and scientific developments in domestic and foreign literature and their citation.

• Active participation of the center's employees in the work of specialized conferences.

• Professionalism of the staff of the center - work experience, previous trainings and current activity to improve the skills of employees, available certificates and accreditation of the center and its individual employees. The remaining criteria are important in the complex, but, in fact, each of them individually is not decisive. Even a large metropolitan center, generously equipped with the latest equipment, with weak management and low-skilled staff, can have a low workload and a deservedly low reputation. The features of the centers of each of the three levels are described in more detail below.

Level I simulation centers:

Simulation centers of I, regional (basic) level have the following characteristics:

• placed at large hospitals, in many high schools and medical colleges.

• Students of the university (college), residents or doctors of the region in which the center is located undergo simulation training and certification.

• Trainings can be conducted both in different specialties and in one narrow specialty. The training program is mainly focused on mastering basic skills.

• The centers are relatively small, occupying several rooms with a total area of up to 300 m2.

• have a variety of simulation equipment of levels I-VI (phantoms, simulators, individual virtual simulators).

• The budget for equipping with simulation equipment does not exceed 30 million rubles.

• There are up to 5 units in the staff list of the centers: director, secretary-administrator, instructors, and engineer. Training sessions can be conducted with the involvement of teachers of departments or leading specialists of health care facilities.

• The staff of the centers can develop new methods of simulation training, but do not have the authority to test or approve them.

Level II simulation centers:

Simulation centers II, district level are characterized by the following:

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• University students, interns and doctors from the entire federal district where the center is located are mastering practical skills and their certification; users are learning new medical equipment.

• Trainings are held in the Centers both in different specialties and in one specialty. It can also be a highly specialized center that provides educational services in one type of high-tech medical care (for example, transplant ology, minimally invasive cardiac surgery and angiography, etc.).

• located on the basis of leading universities and research institutes, they have premises with a total area of 500 to 2000 m^2.

• The centers have a variety of simulation equipment I-VII levels of realism (phantoms, simulators, virtual simulators, up to complex virtual training systems).

• Centers may have their own experimental operating room (vivarium).

• In the schedule of the centers from 3 to 10 staff positions: the head of the center, secretary-administrator, instructors, IT-specialist, service engineer.

Many lectures and practical training sessions are conducted with the involvement of faculty members or medical specialists, including those from other cities and countries.

• Employees of the centers are required to improve their skills by participating in conferences, trainings and master classes.

• Employees of the centers not only develop new methods of simulation training, but also have the right to test third-party methods.

• Methodological and scientific developments should be cited in specialized literature.

Level III Simulation Centers:

Simulation centers III, federal level have the highest status and can be characterized by the following:

• In addition to students and residents, a significant part of the educational process is aimed at improving the qualifications of doctors and their certification, as well as training teachers of simulation centers of I and II levels (ttt - train-the-trainer programs). The geography of trainees is the entire Russian Federation, as well as cadets from near and far abroad.

New medical equipment is being tested using simulation technologies - on virtual simulators or robots, and users are being trained in the principles of operating new equipment.

• Research on simulation technologies is being carried out at top-level centres.

• Most of the specialties, including narrow specialties, are represented in the centers; training is provided in high-tech types of medical care.

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• The centers are located based on the head, leading universities and clinical research institutions, they are large educational structures, occupy separate floors or buildings with a total area of 1000 m^2.

• equipped with simulation equipment of all levels VII, including complex virtual training systems.

• The Center incorporates a "Virtual Clinic", which allows you to work out the processes of interaction between doctors of various specialties and departments at all stages of patient treatment - from admission to the emergency room, diagnosis and surgery to transfer from intensive care to the general ward and final discharge.

• In our own experimental operating room (vivarium), the skills of interventions gained on simulators are consolidated and scientific and practical experiments are carried out.

• the total cost of equipping the center with simulation equipment exceeds 150 million rubles and can reach up to 500 million rubles.

• The staff list of federal centers includes at least 5 employees and their number can reach 20: the head of the center, his deputy, secretary-administrator, instructors, It specialists, service engineers. In addition, teachers of specialized departments, domestic and foreign lecturers.

• According to principles similar to CMOs, employees of the center should improve their skills on an ongoing basis by participating annually in specialized conferences, seminars, trainings and master classes.

• At the level III center, new methods of simulation training are being developed, which should be cited in domestic and, preferably, foreign literature.

• The Center not only tests third-party methods, but is also authorized to approve them.

Thus, only centers of the III, highest, level, according to the totality of the main criteria, should receive the right not only to develop new methods, but also to test and approve third-party developments; not only engage in the educational process, but actively conduct scientific work and test medical equipment; not only to train cadets, but also to conduct training for teachers of simulation centers of I and II levels (ttt programs). And on the other hand, a large center with a large staff, equipped according to the highest class, but at the same time not leading an active educational and scientific and methodological activity, cannot, in the opinion of the author, claim the status of a “federal” center of the III level.

The accumulated experience of simulation training in Uzbekistan allows, first, to be convinced of the indisputable advantages of simulation training:

• Clinical experience in a virtual environment without risk to the patient;

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• An objective assessment of the achieved level of skill;

• An unlimited number of repetitions of skill development;

• Training at a convenient time, regardless of the work of the clinic;

• Practicing actions in case of rare and life-threatening pathologies;

• Transfer of a part of teacher's functions to a virtual simulator;

• Improving the effectiveness of teaching medical professionals new high-tech techniques, as well as new procedures within the framework of already practiced techniques;

• Reduction of stress during the first independent manipulations.

Thus, a virtual simulator, of course, does not replace traditional forms of training - a lecture, a seminar, watching videos and multimedia materials, curating patients, etc. skills. The above is confirmed by the studies of foreign colleagues, which show that specialists highly appreciate the opportunity to participate in simulation training. Despite the feeling of tension and sometimes real stress when working with such a “difficult patient”, they prefer to see directly the results of the treatment, and not just read about them in textbooks or listen to lectures. Most of all, as the survey shows, specialists value the opportunity to make mistakes and learn from them in a safe educational environment.

In teaching the discipline "infectious diseases", the use of simulation technologies has its own characteristics, associated both with the specifics of the clinical course of infectious diseases, and with the presence of senior students' knowledge and skills in basic theoretical and clinical training modules. The choice of simulation training forms should be aimed at developing a high level of clinical competence in the field of diagnosis and treatment of infectious diseases, which should be integrated with communication and teamwork skills. This will allow you to effectively apply the acquired clinical competence in the specific practice of a doctor.

Prior to using them in working with real patients, students must acquire clinical skills in special centers equipped with high-tech simulators and computerized mannequins that allow modeling certain clinical situations, including those for infectious diseases. In the conditions of training centers, the content of training is aimed not only at mastering individual skills, but also at interdisciplinary training in teamwork, the development of safe forms of professional behavior and communication skills with the patient. However, this requires the creation of such modern simulation centers, possibly within the framework of a clinical education cluster.

Another form of simulation training in the field of teaching infectious diseases, which is no less difficult to implement in practice, can be “standardized patients”,

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which are the best alternative to real patients. They can normally play the role of the patient, including psychological and physiological aspects. Volunteers, laboratory staff, teachers themselves, interns and others can be trained as standardized patients. Analysis of a conditional clinical case also provides for teamwork, which allows students to jointly plan work, distribute responsibilities, help each other, cooperate, interact in a group, discuss, understand and accept each other's point of view or defend their own at each stage - interpretation of the analysis, diagnosis, treatment.

There is already an understanding of the need for simulation medicine, equipment is being purchased, simulation centers are being opened, but so far, there is no main thing - simulation training standards. Now each simulation center operates according to its own program. Programs have been written for clinical residency, resuscitation and non-resuscitation specialists, paramedics. In universities, there is a variation in approaches to learning, methods, structure of classes, methods of assessment. This is connected both with the possibilities and with the traditions of a particular department. It seems relevant to standardize teaching programs for simulation medicine. Given the importance of the problem, it is necessary to take into account the vast experience of foreign clinics and professional organizations in the development of Russian standards. The creation of expert groups in specialties will make it possible to systematize the writing of recommendations.

At the same time, the problems that need to be solved for the successful and effective implementation of simulation training in medical education are identified:

• Creation of the concept of simulation training in the system of medical education in the Russian Federation;

• Creation of a regulatory and regulatory framework for simulation training;

• Development and implementation of educational-methodical and software-instrumental support of the simulation educational process;

• Training of teaching staff for simulation training;

• Financial support of the simulation training system;

• conducting research projects to study the effectiveness of simulation training.

In connection with the involvement of a large number of university specialists in the implementation of simulation training, the general level of readiness of employees to introduce virtual technologies into the pedagogical process increases, thinking in general is modernized; pedagogical approaches of teachers are improved and enriched.

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