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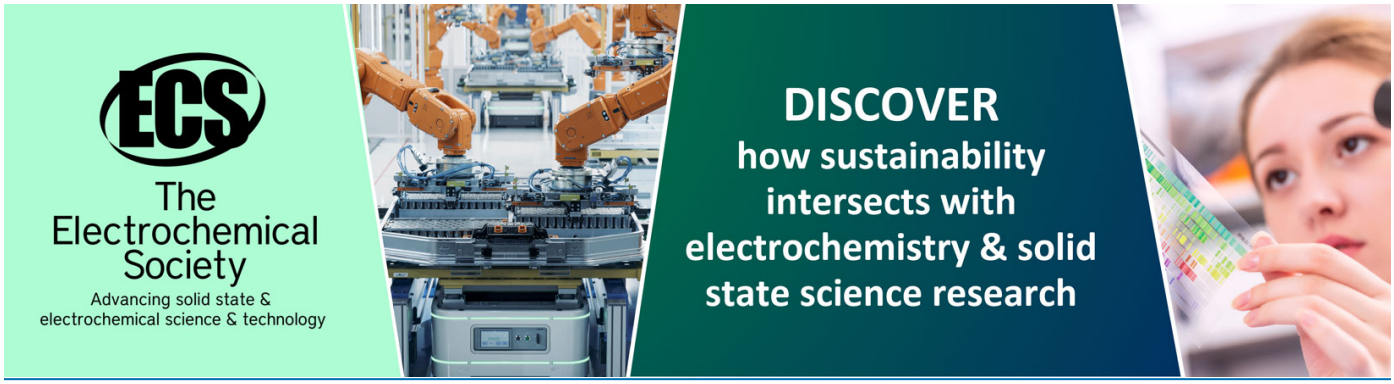

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Simulation based technologies for Professional Training of Managers in the Arctic Region

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Abstract. There are many studies which have arrived at the conclusion that simulation based technology makes a positive impact on learning process. This type of learning ensures active participation and leads to innovative solutions to problems. This study investigates the implementation of simulation based technology with the content in English on the course "Safety Training" for managers of different organizations. The results indicate that using simulation based technology appeared to be a useful tool for creating virtual-reality blended environment and promoting autonomous education. The proposed technology can be used for training and education in a variety of health care situations.

1. Introduction

In 1989, at the initiative of Finland, eight subarctic countries — the USSR (later transferred to Russia), the USA, Canada, Denmark, Norway, Sweden, Finland and Iceland — began to unite efforts to protect the unique nature of the northern polar zone. As a result, the ministers of these countries met in the Finnish city of Rovaniemi and adopted a Declaration on the protection of the environment in the Arctic in June 1991. After that, the Declaration on the establishment of the Arctic Council was adopted on September 19, 1996 in Ottawa (Canada) by representatives of eight Arctic states. The Arctic Council aimed to preserve the integrity of the unique Arctic lands [20]. Russia has successfully introduced work on prevention and preparedness for responding to natural and man-made emergencies. Rescue Centers were created on the territory of northern latitudes, "The Safe City" program complexes were introduced, and the leaders and personnel of the facilities and the public were constantly held in the field of civil defense and emergency protection.

The Arkhangelsk Regional Rescue Service named after Igor Polivany carried out educational courses and professional development of managers and specialists of the near-arctic region in the field of civil defense, protection against emergency situations, and ensuring the safety of people in harsh climatic conditions in the international context. In this regard, it became necessary for training managers capable to organize emergency activity in the process of international communication. Therefore, it was supposed to use simulation based technologies in English content as means of gaining experience to insure safety in risky situations. Simulation based technologies teach managers about realistic decision-making situations involving various changers such as formulating solutions strategies, making decisions by taking into account not only economic but social and psychological considerations and simultaneously improve their language skills.

The main objective of this paper is to identify efficiency of implementation simulation based technologies with the content in English on the course "Safety Training" for managers of international organisations. According the aim, the following issues are to be solved in the article: advances of the simulation based technology with the content in English for managers training, the methods and analysis of the experimental data. The solution of these issues will confirm our presumption about effectiveness of simulation based technologies implementation in "Safety Training" course for managers.

2. Literature review

A number of studies support the effectiveness of simulations for teaching and learning [1, 2, 3, 4, 9, 10, 11, 14, 16, 18]. Simulation based learning approaches aim to imitate a system, entity, phenomenon, or process. They attempt to represent or predict aspects of the behavior of the problem or issue being studied. Simulation can allow experiments to be conducted within a fictitious situation to show the real behaviors and outcomes of possible conditions.

The roots of global simulation technology went back to European reformist pedagogy of the late XIX - early XX century. In the French-speaking countries, the founder of this direction was Selesten Frene. In the pedagogical personality-oriented system of S. Frene, self-development, self-activation, self-realization and autonomy of students, the qualities that can only be achieved through an independent and collaborative process of learning [7]. The main developers of this method are Francis Debuse, Jean-Marc Kar and Francis Yesch [21].

F. Debuse gave the following definition of a global simulation method: "A global simulation is a script that allows a group of up to 30 people to create their own environment, there participants have to use their language skills interacting with each other in this environment and as a result of which they transform a thematic space into a communicative theater" [5].

According to B.E. Avzhanova, educational simulation is a structured scenario with a detailed system of rules, tasks and strategies pursuing a specific goal - the formation of specific competencies that can be transferred directly to the real world [17].

A typology of simulation types derived from the findings of Jonathan Lean, Jonathan Moizer, Michael Towler & Caroline Abbey studies define three types: Computer – based (Gaming situation, Training situation, Modeling situation); None – Computer games (Role Play, Educational Games) [12].Virtual Reality (VR) as a branch of computer simulation, which developed so fast, has been used in various fields such as artistic creation, medical science, entertainment, aviation, space-fight, emergency drill and so on. VR simulation is to generate immersive environments from which users can experience unique insights into the way the real world works [13]. The concept of VR was brought up over fifty years ago when the first immersive human-computer interaction (HCI) named "Man-Machine Graphical Communication System" was invented. The formal term of VR was put up in 1989 [23].VR attempts to replace a user's perception of the surrounding world with a computer-generated artificial 3D environment.

There are many studies which have arrived at the conclusion that VR makes a positive impact on learning process. Xiao Lia, Wen Yib have developed the idea that virtual environment with visual and immersive aids let users feel a "real" sensation. [13]. As reported by Salzmanetal, the higher the sense of presence trainees feel will cause higher motivation which might motivate trainees to work harder to grasp deeper learning [19]. Sh. Pedram, S. Palmisano in their research have concluded that VR technology should be used to train for various operations and dangerous circumstances where it is believed that training objectives cannot be achieved easily or the cost will prohibitive [19]. As stated by Meadows: "When I hear, I forget; when I see, I remember; when I do, I understand" [15]. Therefore, in situations where real life training opportunities are limited, hazardous or impossible, like emergency responses, VR simulators offer the opportunity to emulate a wide range in experiments [20].

In practice Goedert developed a virtual interactive construction education platform which provided game-based safety training through the use of simulation and modeling of education and training

methods [8]. It can be named a 3D game technology, which aims to enhance user interactions, refers to computer-based game-like training scenes through integrating visual, interactive, network and multi-user operating technologies and so forth. As well as Goedert, Guo et al. developed a game-based safety training system, which is an online platform that allows trainees to use input devices, such as keyboard, mouse and game controllers and so on, to operate virtual tasks, such as equipment operation and material delivery [9]. Druzinina, Solovyova studied the issues of "Safety Training" and showed that it is necessary to use new teaching technologies [6].

However, very few publications can be found in the scientific literature that discuss the issue of using game–based safety training system in a none-native language (English). This means that students should integrate such skills as reading and listening instructions in English, translating and understanding specific terminology, making research tasks, doing analytical work and formulating recommendations in the language. The methodology and the game-based safety training system which was used in the experiment are presented next.

3. Participants and study context

3.1 Technology in Use

The study was conducted on the basis of the Arkhangelsk Regional Rescue Service named after Igor Polivany. The class of the center is equipped with an educational and technical complex for training the heads of organizations and operational personnel of emergency response services on potentially dangerous objects in the Arctic region.

3.2 Training Scenario

The program is aimed at professional users in the field of radiation monitoring in the field of radiation contamination in conditions of an extremely radiation-related situation. The users of the system are managers and specialists of enterprises, heads of rescue teams participating in emergency response work involving the release of radioactive substances.

The software complex of interactive three-dimensional visualization (simulator of "virtual reality") is a computer system for simulating the work of mobile radiation reconnaissance tea teams at an early stage of an accident.

The computer simulator is designed for training in the following tasks:

- conducting radiation reconnaissance of the territory;
- identification of places of greatest risk for the population;
- detection of a radioactive source;
- assessment of pollution levels and isotopic composition;
- determination of exceeding the permissible levels of intervention;
- transfer of the received data to the control center;
- implementation of continuous monitoring of dose loads.

The computer simulator completely imitates the real means and devices for carrying out radiation reconnaissance, monitoring and search for sources used in the rescue unit.

There are three basic scenarios of radiation exploration group in circumstances of radiation accident for training.

1. Scenario of dispersion of radioactive dust from the cloud made as a result of the explosion of usual charge surrounded with radioactive substance, dispersion of the cloud under the actions of wind metaconditions and subsequent subsidence of radioactive particles on the underlying surface.

In this scenario a big zone of infection is made. Difficulties of localization of the infection zone are connected with difficult geometrical character of the urban development. It does not let the staff designate the zone of radiation infection in a short time.

2. Scenario of not homogeneous dispersion of radioactive substance fragments as a result of explosion or deliberate spread of radioactive substance on the area of the urban development.

In this scenario an infection zone with some local points in spread of power dose is made. The difficulty of infection zone localization is caused by line of sight lack of radioactive substance distribution zone.

3. Scenario of container laying (possibly damaged), containing highly active point source of radiation. In this scenario there is a point source located among objects of city infrastructure. During localization of point sources a "search" object strategy is used. It is recommended to conduct systematic inspection of all development objects.

The participants of the experiments (managers of organisations and rescue formations) in realistic environment of urban development can freely move in three dimensional space taking into account collision with scene elements, can go upstairs, jump from height, follow changes of a relief. According to the rules of simulation game a participant must:

- Choose "virtual" measurement means corresponding the task;
- Do local measurement of radioactive infection degree. It is possible to move the measurement device (dosimeter) freely in space;
- Choose independently a location of signs "infected";
- Make decisions of infected zone way of the round, planning optimum route of dosimetric control group, taking into account available obstacles of transport and urban architecture.
- On completion of the training phase the leader conducts action analysis of a user, point to mistakes and give recommendations.

At the end of the training phase, the head of the exercise analyzes the actions of the user, indicates errors and makes recommendations.

Figure 1. Three-dimensional simulator for training the actions of personnel of rescue units for the detection of radioactive contamination and the conduct of radiation reconnaissance

3.3 Participants

There are 158 people (79 heads of organizations and 79 supervisors of the emergency rescue unit) who took part in the study in the period from 2013 to 2018. In the process of training it was used the following forms of education: lectures, seminars and practical exercises. In addition to the main forms

of training, the commanders of rescue formations were trained with the help of technical complex (VR stimulator).

4. Methodology

The purpose of this study is to evaluate the effectiveness of training a control group of facility managers without using VR and an experimental group of emergency response crews using VR to take action in radiation and chemical accidents. To assess the effectiveness of the used questionnaires in which students expressed their opinions about the training. At the beginning of the training was conducted entrance control. The purpose of entrance control is to determine the level of knowledge of participants before the start of training. To compare the degree of learning of students, Student's t-test was used. After training, a final test was conducted to assess the knowledge of students. Learning satisfaction and learning perception were assessed using a Likert score based on questionnaires.

5. Results

At the stage of the experimental training the following methods of the study were used: survey, tests, pedagogical observation, methods of mathematical statistics and data processing. Two groups participated in the experiment. The first control group was taught according to the traditional method without using VR. It consisted of heads of organizations (79 people). Before the beginning of the training an entrance test to diagnose initial level of knowledge was conducted in control and experimental groups. The assessment was carried out with the use of a five point scale. The results of the entrance test can be seen in the Figure 2.

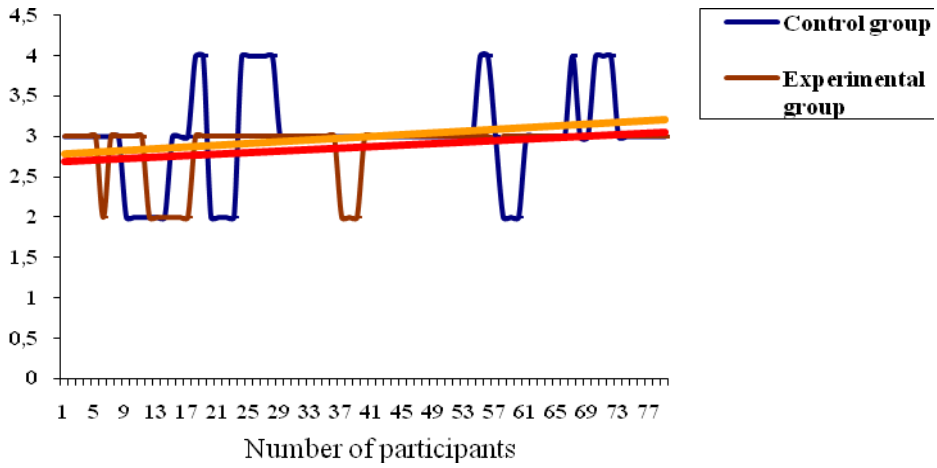

Figure 2. The results of the entrance test in the control and experimental groups

Then the statistical processing of the measurement results was made. Criterion-t by Student was used to assess the reliability of the results, as there were over 50 people who participated in the study. The arithmetic mean, mode and median of the initial level test in the control and experimental groups are presented in Table 1.

Table 1. The arithmetic mean, mode and median of the initial level test in the control and experimental groups.

Group	arithmetic mean X	mode M_o	median Me
Control group	3.0	3	3
Experimental group	2.87	3	3

The analysis of the entrance test (Table 1) shows that the initial knowledge level of the participants in the control group is higher than the initial level of the participants in the control group.

In the control group every value of the level differs from the average value 3 by 0.574. The average value is mode and median. That illustrates the normal distribution of the sample. In the experimental group every value of the level differs from the average value 2.87 by 0.333. The average value is about mode and median, which indicates the normal distribution of the sample.

As follows from the results of the entrance test the initial knowledge level of the participants in the control group is higher than the initial knowledge level of the participants in the experimental group (3.0 > 2.87).

In the experimental group, each value of the series differs from the average value of 2.87 by an average of 0.333. The average value is approximately equal to the mode and the median, which indicates a normal distribution of the sample.

The final test control of knowledge for both groups consists of four tasks with a total of 30 questions. Test control makes it possible to assess:

- knowledge of the features of training in the field of protection from the damaging factors of emergency situations;
- the ability to organize and conduct work to eliminate the consequences of radiation and chemical accidents.

To determine the reliability of the results, the Student's t-test for independent samples was used.

The total number of sample members for both groups is 79.

Calculation of arithmetic mean:

For control group x:

$$x = \frac{\sum xi}{n} = \frac{329}{79} = 4.165$$

For experimental group y:

$$x = \frac{\sum yi}{n} = \frac{363}{79} = 4.595$$

The results of the final testing are presented in Figure 3.

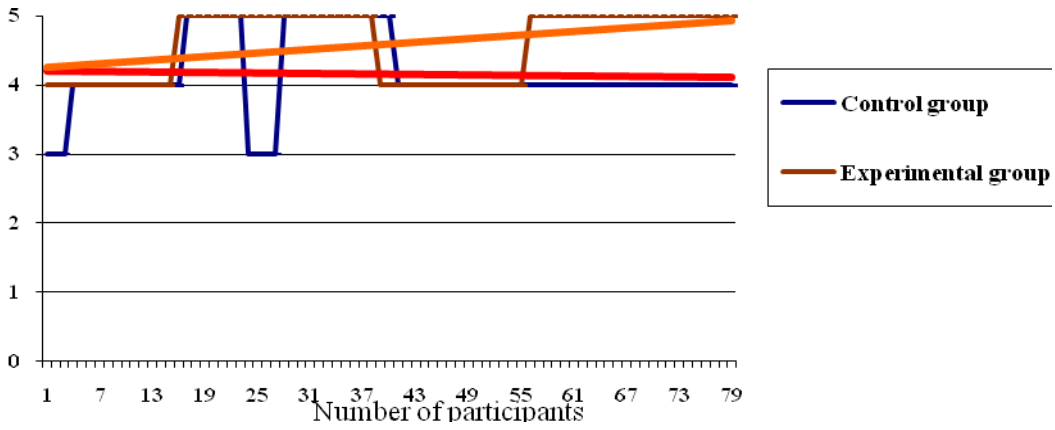

Figure 3. Results of the final control test and experimental group

Standard deviation for the control group:

$$S(x) = \sqrt{S^2(x)} = \sqrt{0}.31 = 0.561$$

Standard deviation for the experimental group:

$$S(y) = \sqrt{S^2(y)} = \sqrt{0}.24 = 0.491$$

Mean error of arithmetic means G = 0.084

Calculate the temp.

$$\textbf{Temp.} = T_{emp.} = \frac{4.595 - 4.165}{0}.084 = 5.11$$

Next, we compare the obtained value of Temp with the theoretical value of T - Student's distribution. In the experiment, Temp = 5.11, tabular Tcr. = 1.99. The obtained in the experiment Temp exceeds the table, therefore, an alternative hypothesis is accepted that the leaders of the rescue formations (EG) showed a higher level of knowledge than the heads of organizations (CG). Temp 5.11> Tcr 1.99, with α = 0.05. The differences in the level between the control and experimental groups are statistically significant with an error level of no more than 5%. Thus, a decision is made about the significance of experiential learning and the use of VR.

The level of satisfaction with the learning process was assessed on the Likert scale based on the questionnaires of students [14]. The analysis of the questionnaires showed that the participants satisfaction with the quality of learning in the experimental group using VR (97.55%) is higher than in the control group (CG) trained with the use of traditional methods (65.35) - presented in Figure 4.

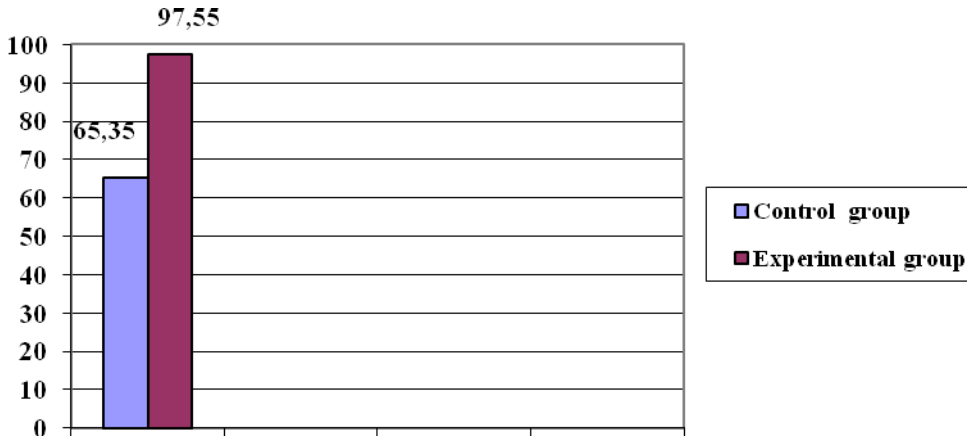

Figure 4. Student satisfaction with the learning process

The assessment of the level of satisfaction with the students' training showed that the learning process using VR is higher than traditional training.

6. Conclusion

In this research, a comprehensive review regarding simulation based technologies in construction the course in "Safety Training" for managers of organisations has been conducted and the experimental methods, application areas and future research directions have been identified. Based on the literature review of stimulation based technologies in particular VR stimulators have enormous potential to increase the quality of professional safety training of managers of the near-arctic region. The data obtained during experiment indicate that our presumption about effectiveness of simulation based technologies implementation in "Safety Training" course for international managers is confirmed. Using VR-based educational program with none-native (English) content didn't cause poor results and on the contrary became an additional stimulus for improving managers' language skills. The design of the courses with the use of simulation based technologies appeared to be a useful tool for creating virtual-reality blended environment and promoting autonomous education. The proposed technology can be used for training and education in a variety of health care situations.

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