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THE EFFECT OF EARTHQUAKE PREPAREDNESS TRAINING COURSES THROUGH GAMIFICATION ON THE STUDENTS' KNOWLEDGE LEVEL

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Abstract

Preparations before earthquakes consist of two items: preparing the physical environment and identifying safe places. Preparation for the earthquake includes familiarity with the dangers during the earthquakes as well as learning to deal with them. This research aims to evaluate the effectiveness of earthquake preparedness training courses by gamification in a virtual reality environment on students' knowledge level. The study included 32 fifth and sixth grade elementary students. Data were collected before and after intervention with a questionnaire. Students were divided into two control and experimental groups. While Students in the control group received lectures and watched movies, the other group was trained through a designed gamification course. The ANCOVA test was used to compare the students' scores of two groups. The results indicated the positive effect of safety earthquake preparedness training against this natural disaster through gamification compared to the traditional method. The findings of this study can be used to develop earthquake preparedness education.

Keywords: Effectiveness, Virtual Reality, Earthquake Preparedness, Knowledge level.

INTRODUCTION

1. Background

Teachers need to determine which of the available teaching approaches can enable students to actively participate in the learning process (1). Teachers can use various types of modern teaching techniques to connect with their students (2). However, lecturing remains the most employed tools for information transmission (3). While every educational subject needs its unique technology, many of the learning approaches used for interaction involve one-way, asymmetric communication, meaning that information is delivered but not exchanged (4).

Education is indispensable for society to survive and thrive, thus to meet the challenges of the fast-changing and unpredictable globalized world, it should be not only comprehensive, sustainable, and superb, but also ever-evolving (5). The role of technology is to facilitate this process by increasing the efficiency and the effectiveness of education (6). Also, instructors should help students make the connection between classroom learning and real-life experiences (1), new technologies can be used to improve the process of learning (7).

In recent years, natural disasters as well as the people affected by them, have exponentially increased (8) Effective educational methods should be designed according to real-life needs. These methods should consider the needed knowledge, skills, attitudes, and values of today's students and how instructional systems can meet these demands (9).

Virtual reality (VR) can be used as a technology in educational approaches because of its capacity to provide visualization of multi-sensory interaction with the visualization space (10). The experiential nature of VR supports a constructivist approach to learning (11). One of the advantages of this emerging technology is that the world of three-dimensional graphics has neither- borders nor constraints and can be created and manipulated by ourselves as we wish (12). In addition, this training, as a process of discovery, exploration, and observation can build knowledge forever (13). The feeling of being in a virtual reality environment is achieved by relying on the five pillars of immersion, interaction, real time, emotions and cognitive sciences (14).

2. Objectives

This research aims to evaluate the effectiveness of earthquake preparedness training courses by gamification in a virtual reality environment on students' Knowledge level. The result of this research can help curriculum planners to deepen the level of knowledge of trained individuals in the context of virtual reality with the subject of earthquake safety.

3. Methods

The game affrication process and the designed method: This game was produced in 2018 in Iran. The story of the game is set in an environment where an earthquake strikes Mercury IX, a situation in which the general public feels terrified. The software is designed with the modeling of the classroom environment of school classrooms, which has been able to adapt to educational locations in other countries. In this environment, there are rows of benches. There is a blackboard and a desk with a computer on it in front of the benches. There are large lockers which are places for teaching aids next to the rooms. Some pots are at risk of collapsing during the earthquake on the cupboards; they have been considered to enhance understanding of the danger in this environment. The classroom has large windows. Although these windows transmit light into the room, the risk of their falling can be an important reminder for earthquake preparedness because of their shielded glass. Gluing glass, finding first aid kits, moving dangerous objects, proper shelters, and saving lives are the things that receive points in this game. In addition, at the end of the game, the player can see his or her survival percentage on the blackboard. The designed educational method for this study is simulated like an escape room but in the context of virtual reality. At first glance, this classroom, unlike other classrooms, is empty of real desks, benches, and blackboards, and after installing the virtual reality glasses, the player can see the graphical environment in which the classroom is conceivable. No one writes a pamphlet and no oral or written tests are given; a class that does not have a teacher and may be accompanied by a facilitator at the user's request. The time is limited and the puzzles are clear. At each stage, the player enters the next level by passing an immunization stage. Students are free to choose the activities and the order of doing them. Consequently, this has no effect on the received points.

Figure 1*:* Simulated class in graphical software environment

The intervention process: This research was conducted in Shiraz (southern Iran). 32 male and female elementary school students (the academic year 2020-2021) participated in this study; they were fifth and sixth grade students. These students were randomly selected and then were divided into two groups, 16 students in the experimental group and 16 students in the control group. Half of the experimental group were girls and the other half were boys. The students' intelligence, social status, parental literacy level and age were considered as control variables.

Before any test, all subjects participated in the pre-test and answered the 16-item researcher-made questionnaire which was validated by the experts. The questionnaire was based on the Likert rating scale and 30 minutes were allocated to the participants to answer its questions.

Designed questionnaire: after the literature review 21 questions were chosen for the first version of the questionnaire, of which 5 questions were deleted after asking for advice from 10 university professors. Then, a pilot study was done among 10 students. A cognitive interview was conducted with these students aiming to evaluate the question-answer process (15). This kind of interview can help develop or adapt an instrument (16). The students were reading the questions loudly; Interview questions included "tell me what you are thinking" and "what is going through your mind right now" about the questions (15). Thematic analysis was used to analyze the differences between students' interpretation of the questions as well as the real intention of the questions (17). The validity of the questionnaire was confirmed by the university professors and the experts in this area; it obtained a score of 9.8 out of 10. To determine the reliability of the questionnaire, Cronbach's alpha method was used.

According to table 1, considering the amount of Cronbach's alpha which is affected by the number of questions as well as considering the small number of component questions, this amount of Cronbach's alpha is considered as an acceptable value.

The experimental group experienced training in a virtual reality environment by wearing virtual reality glasses. However, the control group experienced training in the common styles including lecturing and watching movies. The components of learning at the knowledge level were two items of preparations before earthquakes (including preparing the physical environment and identifying safe places) and preparations during the earthquakes (including familiarity with the dangers during the earthquakes and learning to deal with them). After educational interventions, a post-test was performed in the form of a close-ended questionnaire using Likert rating scale. The results were evaluated with the help of SPSS software (version 24).

4. Results

The main variables in the present study was the amount of knowledge. This variable had two sub-components of earthquake response learning and preparedness training before earthquakes. Each of these components also had two sub-components. The total score of this variable is obtained from the sum of people's scores in these four sub-components. The following table presents the descriptive indicators of the knowledge variable along with its components and sub-components in the pre-test stage:

As it can be seen from the data in the table 2, the mean and standard deviation of the knowledge variable and its components were almost identical in both groups in the pre-test stage.

The table 3 presents the descriptive indicators of the knowledge variable along with its components and sub-components in the post-test stage.

As can be seen from the data in table 3, the average of the knowledge variable and its components in each experimental group in the post-test phase has increased almost compared to the control group.

One-way analysis of covariance indicated that gamification in a virtual environment is higher than the traditional training method in terms of learning. The scores of the participants in the learning component in the post-test stage were considered as a dependent variable and the scores of the individuals in the same component in the pre-test stage were also considered as an auxiliary variable. The independent variable was also membership in the experimental or control group. Before testing this statistical method, its defaults were checked as follows:

Default of univariate normality: To evaluate the normality of univariate data, the Shapiro-Wilk test was used; the results are presented separately in terms of two experimental and control groups in table 4.

The results of the Shapiro-Wilk test show that the assumption of normality of univariate body was observed in the data of both groups in both pre-test and post-test time stages. Therefore, due to the higher level of significance of the test, the zero chance that the data distribution is normal is not ruled out from 0.05.

Assumption of variance homogeneity: Levin test was used to examine variance homogeneity. The results of this test are presented in the table 5. The results of the Levin test in table 5 show that the assumption of variance homogeneity for the dependent variable is established and the significance level of this index is more than 0.05.

Default homogeneity of regression slopes: The regression homogeneity assumption assumes that there is no interaction between the auxiliary variable and the independent variable. To check and confirm the homogeneity of the regression slope, we must calculate the F value of the interaction between the auxiliary and independent variables. If this index is not significant (significance level is more than 0.05) it indicates the existence of this assumption in the data. Table 6 shows the value of this index: As can be seen, the value of F is equal to 0.655 and its significance level is more than 0.05, therefore the assumption of homogeneity of regression slope is confirmed.

After confirming the existence of test defaults, the results of the univariate covariance test are presented as follows. The following table first presents the results of the main ANCOVA test. According to table 7, the F value of the test for the pre-test effect is equal to 10.82 and its significance level is equal to 0.003 i.e. less than 0.01. Therefore, the results show that the effect of the pre-test was significant and the use of pre-test scores as an auxiliary variable with covariate was effective. The main result of the ANCOVA test is based on the group effect. The value of F related to the group effect is equal to 5.98; its significance level is 0.021 which is less than the acceptable level of error, i.e. 0.05. Therefore, the research hypothesis is confirmed and the result shows that there is a statistically significant difference between the experimental and control groups after adjusting the pre-test scores. Since there are two groups, there is no need to use post hoc tests and comparing the means is sufficient. Therefore, it can be said that the use of the gamification approach has a positive effect on the effectiveness of earthquake preparedness training courses at the knowledge level. In the last column of table 7, the values of the Partial Eta Squared are presented. The discriminant square (effect size index) shows the amount of variance explained and indicates that about 17% of the variance of the dependent variable is explained by the independent variable.

5. Discussion

The study aimed to evaluate the effectiveness of earthquake preparedness training courses through gamification in a virtual reality environment on students' knowledge level. Accordingly, we designed a game for students in a virtual reality environment. Also, we designed a questionnaire to evaluate their knowledge regarding earthquake preparedness. The result of this study indicated that students taking part in gamification courses had better-related knowledge than other students who received educational lectures and watched movies.

A similar study by Abdul Halim from the University of New Zealand found that integrating educational tools such as immersion virtual reality games to increase preparedness and responses to earthquakes, such as earthquakes for deaf children in a comprehensive program is effective in reducing the impact of natural disasters (18).

Today traditional education is not very attractive and they are not able to provide a proper picture of life-threatening scenarios (19). Students who are actively involved in new content remember them better in later stages (20). People who have been trained in earthquake safety are divided into two groups: the first group has the experience of be in present in a real earthquake and the other group has not experienced this event. The gamification environment allows them to be more prepared for the next time if they have had a bad earthquake experience in the past and their poor performance in securing the environment has caused potential damage.

Retrieving previous events by recalling clues cause previous knowledge to be associated with current problems and the person is forced to retrieve knowledge away from events. Overall, an interactive environment paves the way for knowledge retrieval.

The gamification-assisted learning environment contains puzzles that challenge the player's mind and links the learning in traditional classes to practical activities in the virtual reality environment, increasing the likelihood of recalling them under stressful earthquake conditions. Virtual reality and serious games also have potential educational capabilities that can immerse in new educational tools to overcome these limitations. In the virtual reality environment, a sensory stimulus, such as the sensation of sights from an object is transmitted to the retina and to the brain, where it corresponds to the content of memory (21). Virtual reality creates simulated experiences that give the person a sense of being in the real world (22).

The Gamification method is very different from the traditional method. In the traditional method, the learner is obliged to memorize the material and may apply it in the real situation of an earthquake ten years later; at that time, when a teacher is not by his side, he does not even know whether he has reacted properly in that special condition of the earthquake or not. But the virtual reality environment goes beyond this limitation and offers almost complete disaster education. Virtual reality provides a safe environment for training tasks that would otherwise be unfeasible or even dangerous to perform in real life. Due to the immediate experiences of progress and receiving deep learning feedback in this educational method, it is possible to facilitate dealing with problems caused by accidents and review them from different angles focusing on stability in difficult living conditions.

6. Conclusion

Although this study showed the positive effects of gamification, larger student communities are needed to be examined in more detail. By removing control variables in future researches, different versions of the software may be produced. For example, by removing the IQ variable, new scenarios may be considered by curriculum designers and programmers who, due to individual differences, have different menus for Individuals are meant. Also, due to social differences and the lack of familiarity of many students with interactive environments, coaches may be needed to provide background training to teach the main lessons and design an environment as a background for players to facilitate performance in game environment.

Certainly, assessing the level of knowledge will not be the only goal of researchers; other psychological issues can be considered as future research topics. Anticipating more puzzles in game design allows for more interaction with the virtual environment.

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Tables:

Table 1: Reliability of the questionnaire through Cronbach's alpha method (n = 32)

Component	Number of questions	Cronbach's alpha
Knowledge and learning	16	**0.707**

Table 2: Descriptive indicators of knowledge variable and its components in pre-test by experimental and control groups

Variable	Component	Subcomponent	experimental group		control group	
			Mean	standard deviation	Mean	standard deviation
Knowledge	Learn to deal with earthquakes	Familiarity with earthquake hazards	19.06	2.62	18.56	3.405
		Learn to deal with earthquakes	9.75	2.08	10.50	1.71

	Earthquake Preparation Training	Physical environment preparation	13.50	2.36	14.43	2.70
		Identify safe havens	15.31	1.44	14.93	2.59
Total knowledge score			58.44	8.09	57.63	6.06

Table 3: Descriptive indicators of knowledge variable and its components in post-test by experimental and control groups

Variable	**Component**	**Subcomponent**	**experimental group**		**control group**	
			Mean	standard deviation	Mean	standard deviation
Knowledge	Learn to deal with earthquakes	Familiarity with earthquake hazards	20.81	2.536	19.31	2.892
		Learn to deal with earthquakes	12.00	1.633	11.31	2.152

	Earthquake Preparation Training	Physical environment preparation	15.75	2.380	14.81	2.287
		Identify safe havens	14.56	1.999	15.00	2.191
Total knowledge score			60.44	7.052	63.13	6.781

Table 4: Evaluation of univariate normality of data by Shapiro-Wilk test

	Control Group		Experimental Group	
Time stage of experimental	p-value	test value	p-value	test value
Total learning score in pre-test	.343	.940	.416	.945
Total learning score in the post-test	.511	.951	.760	.965

Table 5: Levin test results to check the homogeneity of variance error

The dependent variable	**Levine test**			
	Significance	df_2	df_1	**F**
Total learning score (knowledge)	.982	30	1	**.001**

Table 6: F test results to investigate the homogeneity of regression slope

Source	The sum of the squares	the mean of the squares	DF	p-value	F value
Interaction of pre-test variable and independent variable	29.277	29.277	1	.425	**.655**

Table 7: Results of analysis of covariance to compare the mean scores of the total learning level of the two groups in the post-test stage after adjusting the pre-test scores

The source	the sum of the squares	degree of freedom of the hypothesis	the mean squared	F value	p-value	Partial Eta Squared
pre-test	1999.608	1	1999.608	10.822	.003	**.272**
group	1106.466	1	1106.466	5.988	.021	**.171**
Error	5358.580	29	184.779			
Total	8595.719	31				