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The Effect of Fire Training Given with Virtual Reality Applications on Individual Awareness

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Abstract: The use of virtual reality applications, which entered our lives with the concept of Industry 4.0, in training contributed to increasing the security awareness of individuals and indirectly to developing security culture studies. Obviously, the maximum efficiency that can be obtained in Occupational Health and Safety studies will occur due to behavioural changes in employees. For this reason, it should be ensured that the safety perceptions of the employees are kept at the highest level with appropriate and continuous training. In recent Occupational Health and Safety studies, the importance of developing technology has caused these studies to evolve in a different direction. The study's main purpose in this context is to evaluate whether the fire training given with virtual reality applications contributes to the development of fire safety skills and raising awareness in individuals. This study aims to reveal the teaching of basic fire safety skills to vocational and technical students and academicians at universities, their fire preparedness and their common behaviour in fire situations by using fire extinguishing systems through virtual reality and fire simulation. In the study, 47 questions including one group pre-test post-test, 31 prepared for the scale and 6 interview questions, one of the experimental methods consisting of 10 multiple-choice questions, the scale and face-to-face interviews were conducted. Participants were able to moderately to completely control events in terms of heredity, adaptation/containment, and sensory attachment; In terms of interface quality, it has been determined that they can control events between none and moderate. There is no significant difference between the presence levels and sub-dimensions of the participants in terms of age factor. It can be said that the training with virtual reality is effective in improving the success of the participants in fire training. After the study, it was determined that 38 out of 40 participants increased their success in fire protection subjects. It will be ensured that the fire training given in Turkey will be given more efficiently and effectively by using technological infrastructures. With the feedback received from this study, the existing virtual reality application improvement and virtual reality applications that are planned to be developed will be studied.

Keywords: Fire training, virtual reality, readiness, occupational health and safety, TVET

1. Introduction

Traditional fire training starts with theoretical training in which short-term basic combustion information is given and then is completed with theoretical training in which the fire in a metal container filled with fuel is intervened with mobile extinguishers. Among the most important issues to be discussed here are the mastery and competence of the trainers, administrative issues such as whether the training subjects are given within the framework of the legislation, as well as technical issues such as the incompatibility of the training places and training aids with the standards, and the

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inability to decide and evaluation for the participants at the end of the training. It is of vital importance for both employees and businesses that fire drills, which have become mandatory with the entry into force of the Regulation on the Protection of Buildings from Fire, are carried out effectively and in a manner that achieves their purpose. Existing fire training practices are open to development and improvement. The most important step of fire safety is to take the necessary measures to prevent fire. With a better understanding of the fire hazard, the danger perception and risk assessment ability should be improved, and the importance given to the protection measures should be increased. In this context, within the scope of the regulation on the protection of buildings from fire in fire training, minimizing the fires that may occur during the operation, maintenance and use of all kinds of structures, buildings, facilities and businesses, providing fire safety information about fires that may have serious consequences in both houses and workplaces, It is aimed to define the risks that create a fire, to show the precautions and behaviours that should be taken to prevent a fire, and to teach the evacuation methods and ways in case of fire (İnce, 2023). As an alternative to traditional fire training, today's employees receive this training by using modern imaging technologies.

Deutsche Gesetzliche Unfallversicherung stated that virtual reality is a method that can be used in Occupational health and safety applications in a way that can be simulated, optimized, and analysed for each stage of the product lifecycle. In this context, many industry experiences such as firefighting, the use of high-cost and dangerous equipment, explosion simulation, and logistics training with difficult transportation are experienced within the scope of virtual reality applications (Ensari Özay, 2021).

The use of modern imaging technologies, such as augmented reality or virtual reality, is increasingly becoming the standard in industrial solutions. Due to the increased availability of virtual and augmented reality devices, different types of training for employees focused on machine and equipment operator training, maintenance training, or remote resolution of existing machine problems and repairs have been carried out in collaboration with experts from outside the industry, increasing their effectiveness. With the help of this technology, safe training can be provided by developing experiences and skills without entering the harsh conditions and dangerous environments that may be encountered in the real world (Özeren et al., 2021).

In cases where it is possible to simulate individual workflows in controlling a device or to simulate the errors of such devices caused by them, it is quite common to carry out training of device operators through virtual reality (Lacko, 2020). Employees who perform maintenance and repair work can learn how to operate devices relatively simply without having to use real equipment in factory operation. The possible use of augmented reality, which has been incorporated into our lives with Industry 4.0, is to view workflows together with real devices or to view the current status of devices directly in situ (Lacko, 2018). Such simulations require covering a relatively large number of situations that can occur when operating the equipment and moving within the factory's manufacturing and non-production areas.

Virtual reality is used in a wide range of educational activities in various areas of industry. As part of traditional practices, occupational health and safety training are provided through video training or lessons by the people responsible for compliance with occupational health and safety rules. However, the inclusion of virtual reality applications in these trainings brings with it many advantages (Sekerci, 2016).

The most common type of training is the use of these applications to train employees in their work activities, especially related to the dangerous work they perform (Yıldız et al., 2019) (Devidekova et al., 2017). The application can be carried out on different platforms not only for virtual reality but also for augmented reality. These approaches can be evaluated according to both objective and subjective criteria (Gavis et al., 2015). Many applications are specifically designed for different areas in the industry (Zawadzki et al. 2018).

Virtual reality applications in the field of occupational health and safety are applied in various areas of industry, especially in mining (Tichon and Burgess, 2011), construction (Wang et al., 2018) (Sacks and Barak, 2018) (Xie and Shi, 2006) or fire safety (Olivia et al., 2019). Research investigating whether virtual reality enhances security skills and in which areas of learning or skill development this environment excels is an important part of research in this area (Tichon and Scott, 2019).

As a result of Yeliz and Tunca's research in 2020, where employees on the feeling of being found were compiled under four different themes; It is possible to say that there is no consensus yet in the international literature on the terminology of virtual reality and the feeling of being. However, the fact that there are very limited numbers of studies in Turkish literature is a remarkable finding. It is seen that the factors affecting the feeling of being found are the cognitive–psychological characteristics that individuals have. When viewed in a sensory context, it is seen that auditory and olfactory stimuli compatible with the environment contribute to increasing the sense of presence and reality. In addition, in the use of tactile and auditory stimuli, the synchronization of the stimuli with the movements of the users in the real world has an important place (Geriş and Yeliz, 2020).

The aim of the study, conducted by Marelott et al. in 2021, is to examine the effects of immersion, the feeling of being here, and the interaction between these two factors on conceptual and transactional learning performance. The design or use of the 3D environment requires the identification of the environmental conditions that are most suitable for both the characteristics of the training areas and the profiles of the trainees. The study shows that immersion supports procedural learning but does not encourage conceptual learning, and neither the sense of presence nor the interaction between immersion and presence affects both types of learning in the educational task. Apart from fever

information, it was determined that the variables considered in the study (computer experience, video game experience, and gender) never influenced training performance (Marelott et al., 2021).

The field in which most of the research on this subject is concentrated is in the field of education. In a current review, Williams et al. (2015) found 26 games, serious games, or simulations related to fire safety and firefighting, allowing game developers to depict emergency scenarios in a semi-realistic style that could greatly benefit firefighter training; however, the ability to completely recreate real-world dynamic fire simulations, which is exactly accurate, has also been noted to be beyond the technological capabilities currently available (Williams et al., 2015).

Ooi et al. (2021) have created a virtual reality (VR) disaster prevention training system focused on fire disasters to facilitate disaster prevention training, and the system has three modes: VR evacuation drills, VR firefighting training and VR comprehensive training. First, VR evacuation drills can be learned by users by gaining experience in evacuation methods in fire situations. Second, users can go through VR firefighting training by gaining experience in extinguishing methods. Finally, in general training, users can experience trial training in case of fire based on knowledge gained in evacuation and fire drills. In the experiment, which was carried out by dividing the participants into two groups: one group was trained with the methods available using teaching materials, while the other was trained with the proposed virtual reality method. Extensive VR training and an IMMS assessment were then conducted to investigate whether this system demonstrates an improvement over the current teaching method. The results showed that the proposed system achieved better results in terms of attention (+1.58), relevance (+0.7), trust (+0.2), and user satisfaction (+2.16). Furthermore, for groups trained with the proposed system, the player's average evacuation risk during VR-scoped training was -6.45p, the firefighting start time was -10 slower, and the user was able to act safely and quickly against disasters (Ooi et al., 2021).

Considering the existing evidence that the virtual reality (VR)-based education method can be a new and effective approach to learning and practice, Zang and his colleagues (2017), believe that fire safety education is very important for every student within a campus, conducted a study to improve the impact of fire safety education on campus. However, the researchers who stated that the existing VR-based system for fire safety training has some shortcomings such as lack of interaction and high equipment complexity, which will result in low applicability, have tried to create the model and architecture of the fire safety training system based on VR technology. In its work, the framework and various elements of the fire safety training system are designed and implemented according to the combination of relevant fire safety training theory and VR technology. Finally, the prototype version of the fire safety training system based on VR technology is built on HTC VIVE helmet equipment. Through usability testing and comparative analysis of the application experiment, the experimental results prove the feasibility and effectiveness of the proposed approach (Zhang et al., 2017).

According to Avcı (2019), Disaster trainers, teachers and students found the use of technology in disaster education quite necessary and useful, and they claimed that applied methods which make students active besides theoretical knowledge should certainly be included in disaster education. It was concluded that the student's views made a significant difference in some sub-dimensions according to variances of gender, class level, school type and the condition of feeling ready for the disaster (Avcı, 2019).

Studies also show that virtual reality applications have a great place in education, especially in the development and internalization of behaviours to be performed in situations defined as dangerous. This study aims to increase the awareness of people who have completed their basic training on occupational health and safety in accordance with the national legislation on fire safety, to evaluate virtual reality applications and readiness.

2. Application

In this section, the process of teaching basic fire safety skills, fire preparedness and common behaviour in fire situations of students and academics in universities, by using fire extinguishing systems, through virtual reality and fire simulation was carried out. Within the scope of the study, 47 questions including one group consisting of 10 multiple-choice questions pre-test post-test, 31 prepared for the scale and 6 interview questions, one of the experimental methods, the scale and face-to-face interviews were conducted. The statistical evaluations that emerged as a result of these applications are stated under the following headings.

2.1 Purpose

The aim of this study is to teach basic fire safety skills to students and academicians at universities, their fire preparedness, and their common behaviour patterns in fire situations by using fire extinguishing systems through virtual reality and fire simulation. To determine the factors necessary for the more realistic, effective, and efficient use of virtual reality in fire education. The study presents several recommendations to improve the current environment. Unlike the studies conducted, in this study, the effect of the training prepared with virtual reality on the success and attitudes of the participants was examined. In the research, the effect of personal characteristics (gender, age) on the feeling of presence in the virtual environment was also examined.

By analysing the data, the effectiveness of the fire simulation application with virtual reality will be evaluated and improvements will be proposed in the application. The results will be able to contribute to other applications and training, and the findings that can be used in occupational health and safety training will be revealed.

2.2 Research Materials

In this study, which was conducted to teach basic fire safety skills to academicians and students working at the university in Bursa, to reveal their status of being prepared for fire preparedness and common behaviour patterns in case of fire, 47 questions, including 10 questions prepared for the application by using the following applications and scale, 31 and 6 interview questions prepared for the scale, were used in the application, scale and face-to-face interview study.

a) Application of a single group of pre-test post-test research designs from experimental methods consisting of 10 multiple-choice questions,
b) Realization of fire application with virtual reality training,
c) "Sense of Presence scale" consisting of 31 questions in total with age and gender parameters adapted to Turkish with the study conducted by Gökoğlu and Çakıroğlu (2019) developed by Witmer and Singer (1998) to measure the readiness of the participants.
d) Face-to-face interview questions consisting of six questions to increase virtual reality training efficiency.

As a result of these applications, the research objectives are, it will be tried to determine what the participants feel about the fire training prepared with virtual reality, what level they are and what the differences are according to the demographic characteristics of the participants after the fire training prepared with virtual reality.

2.3 Method

The universe of this research consists of the university located in Bursa. A total of 45 students and academicians selected from the university on a voluntary basis participated. 15 Academic Staff and 30 students were studied. However, due to the pandemic conditions and some practices that could not be done, the work continued with 15 Academic Staff and 25 students. To answer the question of how large the sample size should be, simulation studies conducted by different researchers offer some approximate numbers, but these may not be suitable for all situations, so they should not be taken as definitive information. Because simulation studies are carried out under certain special conditions. In their simulation study, De Winter et al. (2009) reported that even a sample size of fewer than 50 people is sufficient when factor loads are high, the number of factors in the model is low, and the number of observed variables is high. For example, the single-factor model with 6 observed variables (items) with a factor load of 0.60 reached appropriate values with a sample size of 18 people. Nevitt and Hancock (2004) emphasized that the complexity of the model is important in determining the sample size in their study. For this reason, the 10-fold rule is considered more appropriate than the 5-fold rule, but there are cases where this is not sufficient. In the bootstrap study, they conducted with continuous variables not suitable for normal distribution, appropriate results were obtained in sample sizes between 200-1000. The fit depends on the complexity of the model. In very simple models, 100 people may be sufficient. It has been suggested to use more than 250 bootstrap samples in studies in terms of the accuracy of the estimations.

Participants were given a pre-test prior to the training to determine their knowledge of basic fire safety. Then, using the fire simulation fire extinguishing system with virtual reality, in appropriate groups, the date and timing of the training were arranged, and basic fire safety training was given to the participants. After the final test and due diligence, a scale was applied to the participants to measure their readiness. In this application, the "Sense of Presence scale" was used together with demographic characteristics and a total of 31 parameters were analysed.

The sense of presence scale was first developed by Witmer and Singer (1998) to measure the level of presence in 3D virtual environments subjectively, in 2005, the scale was revised, and the factor structure was revealed with another research conducted by Witmer and others. With the study of Gökoğlu and Çakıroğlu (2019), the items of the scale adapted to Turkish were converted from a 5-factor structure 7-Likert type to a 5-point Likert type, unlike the original scale. Finally, a face-to-face interview was held with the participants to increase the efficiency of the virtual reality training and they were asked to answer the interview questions consisting of 6 questions.

Statistical analyses of the Study's Sense of Presence Scale were arranged with the Microsoft Excel 2016 program. IBM SPSS 28.0 program was used to determine the suitability of the data for normal distribution and to determine the differences between the groups. To determine the suitability of the data for the normal distribution, the skewness and flatness values for each analysis and group separately, the values obtained from the standard deviation division of the skewness and flatness values, the results of the Kolmogorov-Smirnov test were examined. Skewness and flatness values should be between -1.5 and +1.5 to decide that the data are appropriate; The p-value obtained from the Kolmogorov-Smirnov test is based on a value above 0.05 (Tabachnick, Fidell & Ullman, 2007).
In Table 1 below, the research questions, data collection tool and analysis of the study are included.

Table 1 - Data collection tools and data analysis

Research questions	Data Collection Tool	Data Analysis
1. What is the feeling of presence of the participants about the fire training prepared with virtual reality?	Interview	Content Analysis
2. What is the level of presence of the participants about the fire training prepared with virtual reality?	Presence Scale	Percentage, frequency, average
3. Do the presence levels of the participants after the fire training prepared with virtual reality differ according to demographic characteristics?	Presence Scale	Independent Sample T-Test, One-Way Analysis of Variance
4. Is the fire training prepared with virtual reality effective on the success of the participants in fire training?	Success Test	Wilcoxon Marked Rows Test

2.4 Research Model

In this study, a case study approach was used, which provides a basis for investigating many situations such as education, society, and cultural situations (Yin, 2009). It is important to describe the situation that will be examined in case studies and to exclude other subjects from the scope of the research in terms of ensuring validity. This research examines how academicians experience the virtual reality environment and their level of presence, and it has a single-state pattern. The single-state pattern is a research design in which a single analysis unit (an individual, an institution, a school, etc.) is examined. This design is preferred when three types of situations are encountered. The first is to use it to confirm or disprove a proposed theory. The second is to examine situations that do not meet the standards, contradictory, or idiosyncratic. The last is the study of situations that other studies have not dealt with before.

2.5 Population and Sample

The universe of this research consists of the university in Bursa. A total of 45 vocational and technical students and academics, who were selected from the university on a voluntary basis, participated. The study was applied to 15 academic staff and 30 students. However, due to the pandemic conditions and some applications that could not be carried out, the study continued with 15 Academic Staff and 25 students. The sampling method is purposeful sampling. Purposeful sampling is the purposeful classification of systematically and randomly selected case samples in line with the purpose of the research. This new sampling is done to reach richer data than the cases determined by random sampling and to increase the credibility of the research. The researcher first determines a sample group from the universe by random methods and then selects a small subgroup from this group that they will contribute the most to the research. This is a small group sample (Baltacı, 2018).

3. Result and Discussion

For the analysis of the second, fourth and fifth research questions, descriptive statistical analyses such as calculation of mean, sum, standard deviation, percentage and frequency measurements were performed.

According to the normality test results for the third research question, it was concluded that the data were among the values determined in all groups and were in accordance with the normal distribution. The results of the detailed normality tests are shared in the appendices. To determine the difference between the levels of presence of participants in terms of gender factor; an independent sample t-test was preferred due to the normal distribution of the data, the difference between the two groups and the independence of the groups. To determine the difference between the presence levels of the participants in terms of age factor, One-Way Variance analysis was preferred due to the normal distribution of the data, the difference between more than two groups and the independence of the groups.

For the fourth research question, the Wilcoxon Marked Sequences Test was preferred to investigate the difference between the pre-test and the final test since the data were not distributed normally, the difference between the two dependent groups and the dependent causes of the groups.

The Sense of Presence Scale applied in the study was prepared for secondary school students. For this reason, confirmatory factor analysis (DFA) was performed, and expert opinions were obtained in order to use the scales in our study. According to the DFA results for the presence scale ($\chi 2$ /df = 1.86; RMSEA = .149 (CI 90% [.05, .07]); SRMR = .1447; CFI = .499; GFI = .536) was found to be valid and reliable.

In addition, expert opinions were obtained from two academicians working in the Department of Curriculum Development in Education and Computer Education and Instructional Technologies for the implementation of the scales. In this study, Cronbach's Alpha reliability coefficient was used to determine the reliability of the scales. Cronbach's Alpha reliability coefficient is not reliable between 0 and 0.40 according to the values it receives; Low reliability from 0.40 to 0.60; Quite reliable between 0.60-0.90; It is interpreted as highly reliable between 0.90-1 (Can,

2014). According to the results of the analysis, it was determined that the results of the Availability Scale were quite reliable [α=0.874].

The first research question is; "What is the feeling of presence of the participants about the fire training prepared with virtual reality?" The findings of the content analysis related to the question are shared below. The answers given to the suggestions about the problems experienced in the fire training applied with Virtual Reality, the realistic and unrealistic aspects, and how the virtual reality equipment affects the participants were shared according to the most given answers as follows by applying content analysis.

Among the answers given to the question "What kind of problems have you encountered in general?", the most common answer is related to the "Adaptation problem". In addition, Student22 stated that he experienced blurred vision due to the use of glasses.

Among the answers given to the question "What are the realistic aspects in the virtual reality environment?", the most answer is related to the fact that the equipment used is realistic. In addition, Student19 stated that the incident of the comprehension of the fire extinguisher was very realistic.

Among the answers given to the question "What are the unrealistic aspects in the virtual reality environment?", the answer is "The fact that all fire classes are in the same environment does not reflect reality". In addition, Academician8 stated that parameters such as vibration, temperature, and sense of smell should be ensurable in the application.

Among the answers given to the question "How did the glasses and headset used affect your movements in the environment?", the most emphasized was "Could be used faster". In addition to this answer, Student5 emphasized that the glasses cable used in the application is obstructive.

Among the answers given to the question "Do you think you can apply the knowledge you have learned here in the event of a fire you will encounter in real life?", the most answered was the one that the participants stated that they could apply with 80% of the answers. In addition, Academician14 stated that it can be applied depending on excitement and panic.

Among the answers given to the question "How should fire safety training be given more effectively?", the most emphasized answers were "Temperature effect, feeling, an adaptation of an equipment that blows hot air, inclusion in this training in parameters that can appeal to other sensory organs in the virtual environment and periodic application of practical fire training". In the findings of the second research question; Descriptive statistics on the level of presence and sub-dimensions of the participants are included in the table.

Table 2 - Presence levels of participants

	N	***Min.***	***Max.***	***Avr.***	***S***
Presence Levels	40	2.31	4.79	3.78	.469
Heredity	40	2.11	4.89	4.01	.582
Adaptation/ Containment	40	2.29	5.00	3.83	.684
Sensory attachment	40	2.40	5.00	4.05	.622
Interaction	40	2.20	5.00	3.96	.633
Interface quality	40	1.00	4.67	2.18	.854

According to the table, the level of presence of the participants (X = 3.77; S= 0.47); inheritance levels ($\bar{X}$ = 4.01; S= 0.58); adaptation/containment levels ($\bar{X}$ = 3.83; S= 0.68); levels of sensory commitment ($\bar{X}$ = 4.05; S= 0.62); interaction levels ($\bar{X}$ = 3.96; S = 0.63) and interface quality levels ($\bar{X}$ = 2.18; S = 0.85). Participants were able to control events between medium and complete in terms of heredity, harmony/containment and sensory connectedness; In terms of interface quality, it has been determined that they can control the events between no-middle.

Third Research Question; The results of the Independent Sample t-test conducted to determine the difference between the participants' levels of presence in terms of gender factor were shared in the table.

There was no significant difference between the levels of presence of female participants ($\bar{X}$ = 3.66) and the levels of presence of male participants ($\bar{X}$ = 3.87) [t(38) =-1.397; p=0.46].

During the virtual reality experience, a significant difference was found between men and women in terms of the sub-dimension of interface quality, where the effect of control and the visual interface was tried to be determined. There was a significant difference between the presence levels of interface quality of female participants ($\bar{X}$ = 2.39) and the level of interface quality of male participants ($\bar{X}$ = 2.02) [t(38) =8.108; p=0.007]. In terms of interface quality, it can be said that the gender factor influences the level of control of events.

In other sub-dimensions, no effect of the gender factor was detected.

Table 3 - Independent sample t-test results

	Group	*N*	$\bar{X}$	*S*	*sd*	*t*	*p*
Presence Levels	Female	18	3.66	.525	38	-1,397	0,465
	Male	22	3.87	.406			
Heredity	Female	18	3.98	.686	38	-,315	0,432
	Male	22	4.04	.496			
Adaptation/ Containment	Female	18	3.56	.701	38	-2,307	0,914
	Male	22	4.04	.603			
Sensory attachment	Female	18	3.98	.639	38	-,659	0,963
	Male	22	4.11	.616			
Interaction	Female	18	3.68	.644	38	-2,759	0,581
	Male	22	4.20	.533			
Interface quality	Female	18	2.39	.575	38	1,394	0,007*
	Male	22	2.02	1.010			

*p<0,05

Table 4 - Results of one-way analysis of variance for differences in presence levels in terms of age factor

Source of variance	Sum of squares	*sd*	Squares average	*F*	*p*
Between groups	.852	3	.284	1.325	.281
Within groups	7.710	36	.214		
Total	8.561	39			

In terms of the age factor, there was no significant difference between the presence levels and sub-dimensions of the participants [F (3-36) = 1.325, p=0.281].

Fourth Research Question; The results of the Wilcoxon Marked Ranks Test, which was conducted to determine the difference between the participants' preliminary test scores and the final test scores, are included in the table.

Table 5 - Wilcoxon marked ranks test results for the fourth research question.

	N	Row mean	Row sum.	*Z*	*p*
Negative values	2	9.00	18.00	-5.329	<0.001
Positive values	38	21.11	802.00		
Equal values	0				
Total	40				

p<0.05, finaltest < pre-test, finaltest > pre-test, finaltest = pre-test

According to the results of the analysis, there was a significant difference between the preliminary test scores of the participants ($\bar{X}$ = 70.00) and the final test scores ($\bar{X}$ = 92.50) [Z=-5.329; p=0.001<0.05]. The significant difference is in favour of the last test. It can be said that the training with virtual reality is effective in improving the success of the participants in fire training. The level of sense of presence in virtual reality-based learning environments plays a crucial role in the transferability of skills acquired in a virtual reality environment to real-life conditions (Çakiroğlu & Gökoğlu, 2019). The knowledge level of participants was significantly higher who formerly attended certain courses and disaster drills (Şen & Ersoy, 2019). As a result of the study, it was determined that 38 out of 40 participants had increased success in fire protection subjects, 38 are mentioned in some parts. The study was applied to 40 participants.

These results are also consistent with the results of Jung and Ahn's (2018) study comparing the learning of conceptual and practical knowledge of a complex procedure. According to the results of Jung and Ahn's study, it performed significantly better for the group with an immersive environment for practical skills (Jung & Ahn, 2018). It is worth noting that, as in the work of Jung and Ahn, the interaction between the learner and the system is one of the elements that favour diving into a virtual environment. As pointed out by Bailey et al., (2017), because the participant is physically performing the task, gesture-based commands may be better for learning a procedure. In fact, the

"activation effect" refers to the fact that physically executing an action improves the recall of that action (Engelkamp & Jahn, 2003).

Another result of our study is that the feeling of presence influences conceptual learning and transactional learning. As can be seen, it is possible to come across some studies in the literature that aim to confirm the hypothesis that the feeling of being here affects learning. According to Van Baren and IJsselsteijn (2004), the relationship between the two variables, sense of presence and task performance, is strongly mediated by experimental instructions or individual motivational factors. According to Tepe (2019), Virtual reality applications have created a high level of presence for all students in the experimental groups. The participants expressed positive opinions about virtual reality applications. It was concluded that virtual reality applications could be used as effective course support material in formal learning environments (Tepe, 2019).

Mystakidis et al., (2022) demonstrate the instructional design, development and benchmarking of the FSCHOOL fire preparation serious game in VR for primary school teachers. The evaluation results of the game show that the game is suitable for its purpose and suitable for adult learners. The main contribution of this work is the detailed design of a complex adaptive serious VR game within the convergence of learning and game mechanics. This model can assist practitioners, educators, researchers, developers, and system administrators in creating effective immersive VR games to gain complex conceptual and procedural knowledge and skills in spatial contexts.

Saghafian et al., (2020) investigate how the trainees from safety-critical industries evaluated the use of VR technology for fire extinguisher training. The results showed that more than half of the trainees positively evaluated the VR training and reported having positive emotions during the training session. According to Wahidi et al., (2022), A comparison of conventional occupational safety training with work-based safety training in virtual reality technology is seen from the seven variables in the training process: space, safety, environment, time, equipment, simulation, and assessment. VR-based work safety training simulations can improve the theoretical knowledge of occupational safety trainees by as much as 14.05% based on written pre-test and post-test results. As pointed out by Rahmalan et al., (2020) through the usability testing investigation, the results on using a VR fire extinguisher received more than 80%, indicating that the application manages to give awareness to users on the needs and steps to use a fire extinguisher to extinguish the fire.

4. Conclusion

When the results of the study are evaluated, one of the outputs is that fire training carried out with virtual training improves both conceptual and procedural learning. Virtual reality applications used in fire training have a great place in the development and internalization of behaviours to be performed especially in dangerous situations. In this study, because of the evaluation of virtual reality training, especially virtual reality applications, in the pre-test and post-test application on academic achievement, it is among the results that the participants are effective in increasing the success of fire training. It was determined that 38 out of 40 participants increased their success in fire protection subjects. A significant difference was found between men and women in terms of interface quality sub-dimension, in which the effect of control and visual interface was tried to be determined during the virtual reality experience. In terms of interface quality, it is stated that the gender factor influences the level of control of events.

In recent years, the use of virtual reality technologies for academic learning and vocational training has gradually increased. Especially in the training that should be given for very dangerous jobs in the professional sense, benefiting from virtual reality technologies makes positive contributions to the learning performance of individuals. However, the problems that may be caused by the continuous use of these applications in terms of health, factors such as age and gender should be investigated in more detail in the future. In addition, the design and use of a comprehensive three-dimensional environment require the definition of the most appropriate environmental conditions for both the field to be trained and the profiles of the individuals to be trained. For this reason, the renewal of the training to be given with the help of virtual reality with different environment designs within certain intervals such as classical training will ensure that the perception of individuals is always high.

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