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ORIGINAL ARTICLE

First responders' innovative methodology and curriculum definition for advanced virtual reality training

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Abstract

Within the ASSISTANCE Project (Adapted Situation Awareness Tools and Tailored Training Scenarios for Increasing the Capabilities and Enhancing the Protection of First Responders) the development of a novel and advanced training programme is currently underway to adapt to the needs and characteristics of first responders. Once the methodology was ready, a complete training curriculum was prepared in order to probe the concept of the European training network based on online Virtual Reality platforms. The curriculum is composed of subjects, which have been developed with a stepwise approach, taking into consideration the pre-requisites needed for each subject and a gradual increase in difficulty and complexity. These subjects can be divided into two different types: theoretical subjects, which will be taught through the Moodle server and practical subjects, which will be taught through the performance of different virtual scenarios with the available Virtual Reality platforms. Each subject definition includes a short summary of the subject, their main, general and specific objectives as well as their preferred evaluation method and the pre-requisites needed. This paper presents the ASSISTANCE training methodology and the curriculum developed including the preliminary scheduling needed to complete all the proposed subjects.

Keywords: First responders, virtual reality training, curriculum development, step wise approach, androgogy

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Introduction

The bombing of Oklahoma City in 1995, the attacks on the World Trade Center in 2001, multiple hurricanes that hit Florida in 2004, and hurricanes Katrina and Rita in 2005 are unforgettable events when First Responders (FR) were inadequately equipped to face the emergency. These events have shown us to what extent the natural and man-made disasters can harm human life. They have also highlighted the important role of first responders in protecting citizens for the health and safety of the population [1,2]. The impact of large disasters like these can have disastrous consequences for the European Member States and affect social well-being on a global level. Each type of FR organisation (e.g. medical emergency services, fire and rescue services, law enforcement teams, civil protection professionals, etc.) that mitigate the effects of these kinds of events is exposed to the unexpected dangers and new threats that can severely affect their personal safety. These structures work together to save lives, protect infrastructure resources and the health of the population, which is to restore normality. Among these, paramedics, fire, and rescue services often referred to as emergency first responders, are often the main units within emergency response teams [1-3]. FRs have to perform their work in chaotic and stressful emergency response situations, making the best decisions quickly, based on information about the disaster at hand and its immediate surroundings [1,2].

The aim of the study was to prepare a curriculum for FRs to gain better knowledge and develop skills according to their training needs, which is the first step of the training programme development.

According to Hermans et al., in general adults are a heterogeneous group with a large variety of learning preferences, learning ambitions, prior knowledge and personal circumstances [4,5]. Cercone adds that most adult learners are highly motivated and task-oriented, with Lee et al. expanding on this stating that adults are more independent and self-regulated in their learning [5,6].

Tretsiakova-McNally et al., pose that experience, including making mistakes, provides the basis for learning activities. They also state that adult learning is problem-centred rather than content-oriented, and that adults are most interested in learning subjects that have immediate relevance to their job or personal life [3]. Adults have certain limitations, such as multiple responsibilities (e.g. families and jobs), physiological limitations, and difficulty in dealing with technology (Lee, K., et al., 2019). To overcome this they need real hands-on experience. Virtual Reality (VR) technology offers a broad opportunity to meet the various expectations of adult education theory and enhances the skills and capabilities of FRs [3,4]. Cercone also states that primarily due to their busy schedules and the convenience of the online format, many adults want to take advantage of online learning environments [5]. The objectives of the study are to understand training needs of the FRs for the use of drones, wearable, and robots to enhance their situational awareness, skills and capabilities and develop a VR training program.

Materials and Methods

Approval for conducting the study was obtained from the Noninterventional Studies Ethics Committee of Tepecik Research and Training Hospital (2019/12-16).

Population; the sample of the study consisted of FRs over the age of 18 living in Poland, Sweden, Spain, Netherlands, and Türkiye. The inclusion criteria were determined as being over 18 years old, working as ambulance, fire fighter, and police FRs in the countries mentioned above. Individuals who did not agree to participate in the study or did not completely fill out the survey form were excluded. Before they started to fill out the survey, all participants consented to participate in the study and provided permission for their data to be used.

Data collection; the data were collected between July, 1-31, 2019 on the Survey Monkey platform. The FR Consortium members from Poland, Sweden, Spain, Netherlands, and Türkiye distributed the questionnaire to the FR agencies in their country. Messages including the invitation to participate in the study and information about the study were included in the email.

Participation in the study was voluntary, and before starting to collect data, the participants were provided with an informed consent form to confirm. No monetary or non-monetary incentives were offered to the participants for their participation.

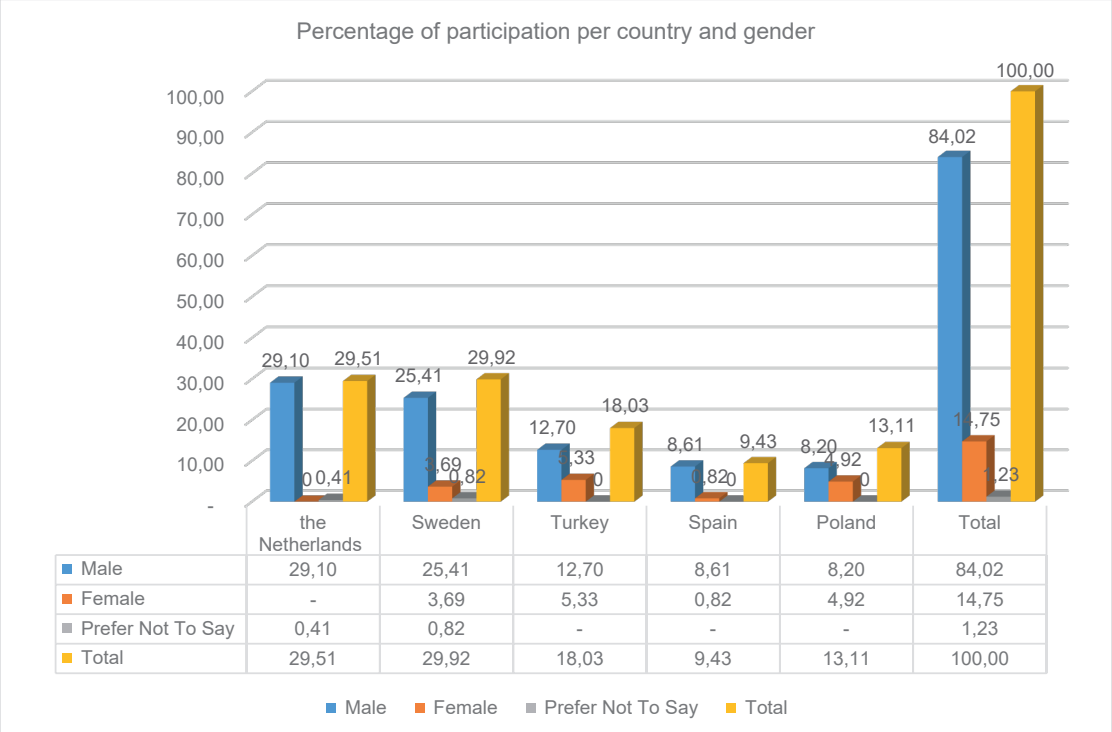
Survey form; the open-access online survey form consisted of questions on the sociodemographic and their current mission type (5 items), their experience with drones, wearable, and robots as situational awareness tools, their preferred learning method(s) (27 items). Totally 32 questions.

Results

In total, 244 responses were received to the developed questionnaire. The country with the highest participation was Netherlands with 29.51% and all respondents were male, excluding one person who did not specify their gender. The participation rate of other countries were 29.92% Sweden, 18.03% Türkiye, 9.43% Spain, and 13.11% Poland (Figure 1).

The majority of the respondents (31%) were males between 35 and 44 years old; furthermore, most women who participated in the survey were between 25 and 34 years old (7% of all respondents). The percentage of FRs between 45-54 years old was 23% and 7% were between 55-64 years old. Most of the respondents perform fieldwork as their mission type (31.14% out of 244 respondents), whereas 18.44% (n:76) of respondents also work in a command/ dispatch function, 18.44% (n:45) in training, 15.16% (n:37) in a managerial function (office), and 16.52% (n:33) in technical support. Most men (42%) work in the field, while 25% of the women work in the field. Three participants worked in emergency services for less than one year and one participant worked for 45 years. The median was 16.5 years, the arithmetic mean was 13.29 years and the mode was 20 years for working years in emergency services as FRs.

The majority of FRs have little experience using the feedback from the proposed technologies. 44.5% of the participants (n:144) do not have any professional experience. They answered 'None' when asked "How many times did you professionally use feedback of drones/wearables/ robots?". Only 0.8% of all respondents (n:2) have used all technologies more than 10 times. The country with the most-trained number of respondents in terms of the use of drones was Poland (78%). The least trained FRs among the



	the Netherlands	Sweden	Turkey	Spain	Poland	Total
Male	29,10	25,41	12,70	8,61	8,20	84,02
Female	-	3,69	5,33	0,82	4,92	14,75
Prefer Not To Say	0,41	0,82	-	-	-	1,23
Total	29,51	29,92	18,03	9,43	13,11	100,00

Figure 1. Percentage of participation per country and gender.

respondents were from Spain (16%) and Sweden (32%). In their free time, 97 FRs (39.7%) do not use the proposed technologies.

FRs have the most experience in gaining knowledge regarding using technical tools (drones, wearables, robots) by handbooks (n:38; 57.6%), and workshops (n:37; 56.1%). For working with drones specifically lectures/ seminars, workshops and handbooks are the most used for gaining knowledge (all n:20; 55.6%). 55% (n:21) of the FRs were satisfied (it was 'fine, good or very good') with the training they have received.

The preferred ways of gaining knowledge and skills were "Training with digital solutions (AR/VR)" with 147 respondents (60.25%) and "E-learning" with 144 respondents (59.02%). The predominant choice for gaining knowledge and skills for other training options were "Workshops" with 120 (49.18%) respondents, "Lectures /

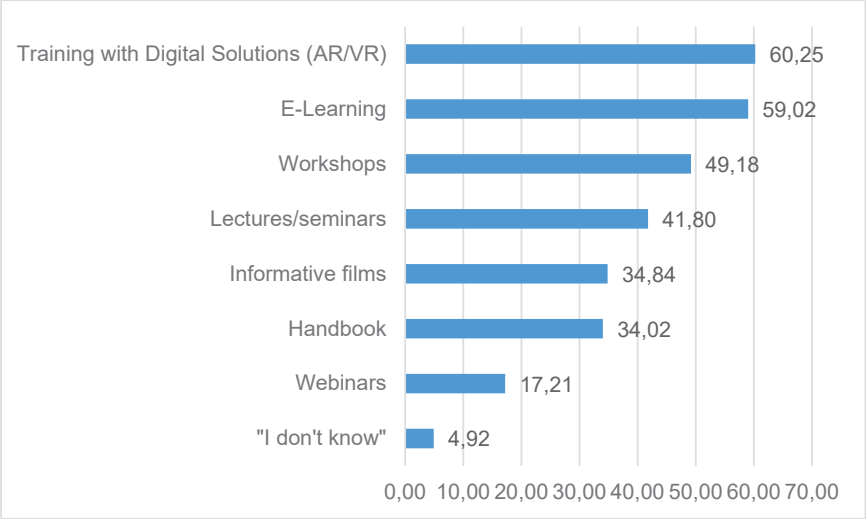


Figure 2. Distribution of preferred ways of gaining knowledge and skills.

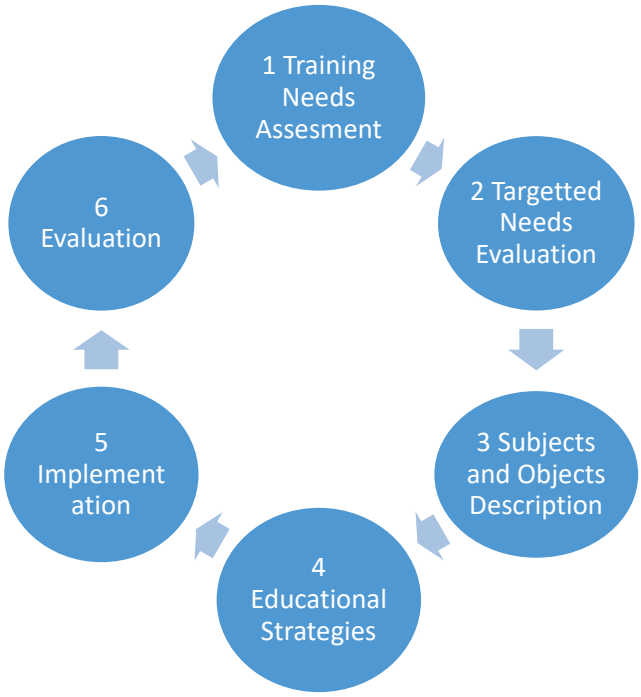


Figure 3. Training curriculum development phases (adapted from Kern's six-step approach to curriculum development [6].

Seminars" with 102 (41.8%), "Informative films" with 84 (34.84%), "Handbook" with 83 (34.02%), and" Webinars" with 42 (17.21%) respondents (Figure 2). The training curriculum was centred on learning with virtual, augmented and mixed reality and elearning for training different FR organisations was highly rated. The target group for the training are European FRs; mainly, but not limited to, paramedics, police officers and firefighters. Based on the training methodology, a tailored step-by-step training curriculum has been composed, consisting of training objectives per step as well as the methods for their evaluation. Development and planning steps of the Training Curriculum (Figure 3):

1. Training Needs Assessment
2. Targeted Needs Evaluation
3. Subjects / Objects Description
4. Educational Strategies
5. Implementation
6. Evaluation [6]

As stated previously a solid literature review, questionnaires and group discussions helped to establish the training needs and methods described in the training methodology as the first step in developing the curriculum. The Targeted Needs Evaluation step, which points the methodology evaluation criteria, has also been defined in the methodology.

The curriculum description includes several subjects that will cover all the necessary learning aspects for the different first responders' organisations (ambulance staff, firefighters, and police) which will test the Advanced VR Training Platforms. Additionally, the curriculum also covers the educational strategies, implementation (scheduling), and evaluation of the subjects.

As such the whole training curriculum developed covers eight subjects, organised taking into consideration the pre-requisites needed for each subject and a gradual increase in the difficulty and complexity. Each theoretical subject (1 to 4) is composed of several lessons. These lessons include the general and specific objectives of each subject.

Additionally, each subject has a determined total duration according to the time needed to read all the material, the exercises, and to conduct the evaluation. This is necessary to build the overall training schedule during the project. Finally, each subject has a mentor, or subject specialist, who is the designated point of contact for concepts which could be problematic for the main trainer. The defined curriculum is composed of the 8 subjects that can be seen in Table 1.

Table 1. Training subjects.

Subject Name	Description
1. Background Knowledge	The first part includes all the minimal background knowledge required to understand the Virtual reality, Augmented Reality and Mixed Reality concepts to help trainees to continue onto the next part of the training.
2. Virtual Reality Platforms	The second part comprises all the subjects that describe the Virtual Reality Platforms and their usage.
3. Virtual Reality Platforms Usage	
4. Virtual Reality Scenarios	The third part is composed of the Virtual Reality Scenarios description.
5. Simple Virtual Reality Scenario	The fourth part provides the performance of Scenarios described in subject 4 through different training sessions. The virtual scenarios described in this subject shall be performed by the trainees through the different VR platforms available in the Consortium within subjects 5 to 8.
6. First Pilot Virtual Reality Scenario	
7. Second Pilot Virtual Reality Scenario	
8. Third Pilot Virtual Reality Scenario	

A brief subject description of the planned lectures is given below:

Subject 1: Background Knowledge

This subject includes the minimum background knowledge that is required to understand Virtual Reality, and Mixed Reality concepts. For example, definitions, examples, online VR platforms for the general public and specific training applications that are currently available to be used by the FRs. The different lessons that comprise Subject 1 according to the Moodle subject structure along with its prerequisites and evaluation method used are described in Table 2.

The rest of the subjects have a similar structure to the one described in Table 2 and they can be consulted in the Moodle server. For subjects 2 to 4 only descriptions of the subjects have been included in this section in order not to make it too extensive. The whole content described in the article is available in the different lessons of Subject 1 at the Training Moodle server.

As an example of the information stated in Table 2, the subjects' table of contents, a screenshot of the content of Subject 1 is included in Figure 4.

Subject 2: Virtual Reality Platforms

Once the background knowledge on VR has been introduced in Subject 1, in Subject 2 the VR platforms available to the Consortium are described. This way the trainees will have an overall description of each VR platform they are going to use during the training exercises before they study the manuals and/or explanatory videos in subject 3, which will enable them to start using these VR platforms. This progressive introduction in the VR applications and available platforms forms a part of the stepwise approach followed in the whole training curriculum development.

Table 2. Subjects Structure.

Lesson Number	Subject Content	Prerequisites	Evaluation method
1.L0	Lesson Introduction	None for subject 1	Review Quiz for subject 1
1.L1	Virtual reality concept	None for subject 1	Review Quiz for subject 1
1.L2	Virtual reality open platforms (Gaming)	None for subject 1	Review Quiz for subject 1
1.L3	Training through Virtual reality platforms	None for subject 1	Review Quiz for subject 1
1.L4	FR training using Virtual reality platforms	None for subject 1	Review Quiz for subject 1

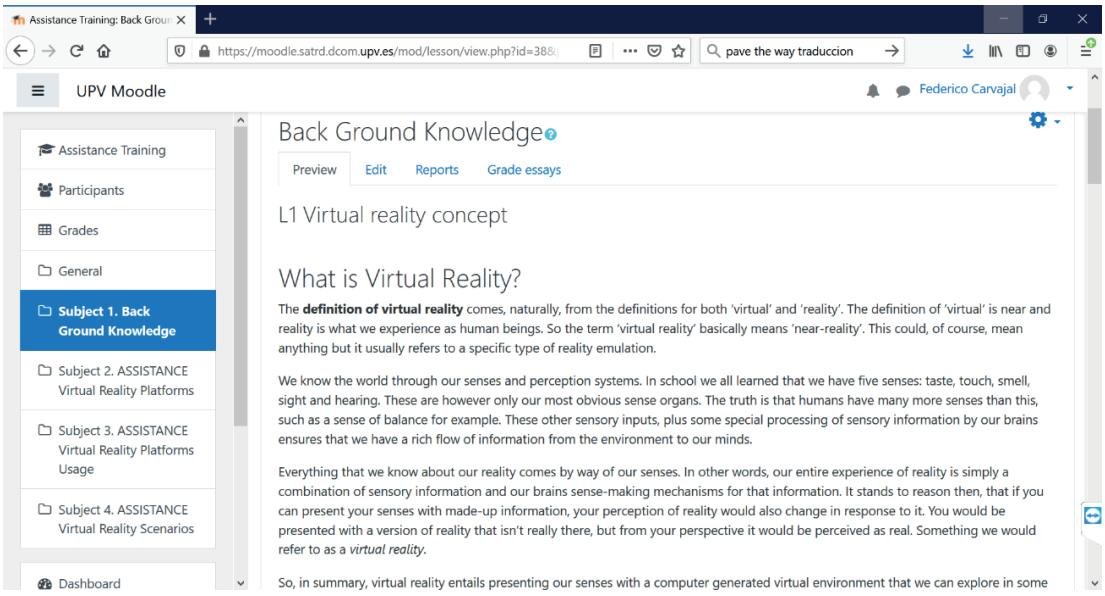


Figure 4. Screenshot showing Subject 1: content for VR general concepts description in the Training Moodle server.

In the first lesson of this subject, the trainees will find a general description of the VR Training Platform (SIMTAC) of Universitat Politécnica de Valencia (UPV) shown in Figs. 5,6 [7] the Instituut Fysieke Veiligheid (IFV) VR Advanced Disaster Management Simulation (ADMS) [8] system shown in Figure 7-8 and VR system of Centrum Naukowo-Badawcze Ochrony Przeciwpożarowej (CNBOP) [9] shown in Figure 9-10; in order to get to know the VR platforms main characteristics before they start learning how to use the platforms in Subject 3.

Subject 3: Virtual Reality Platforms Usage

As the background knowledge on VR functionality and VR platforms has been introduced in Subject 1 and 2, in Subject 3 the dedicated VR platforms (UPV VR, IFV VR, CNBOP VR) usage is described. In this subject, instruction manual on how to operate with each platform provided in the project are shown. Moreover, photos and videos, showing how to use and operate different functionalities necessary to complete the training scenario, are included.

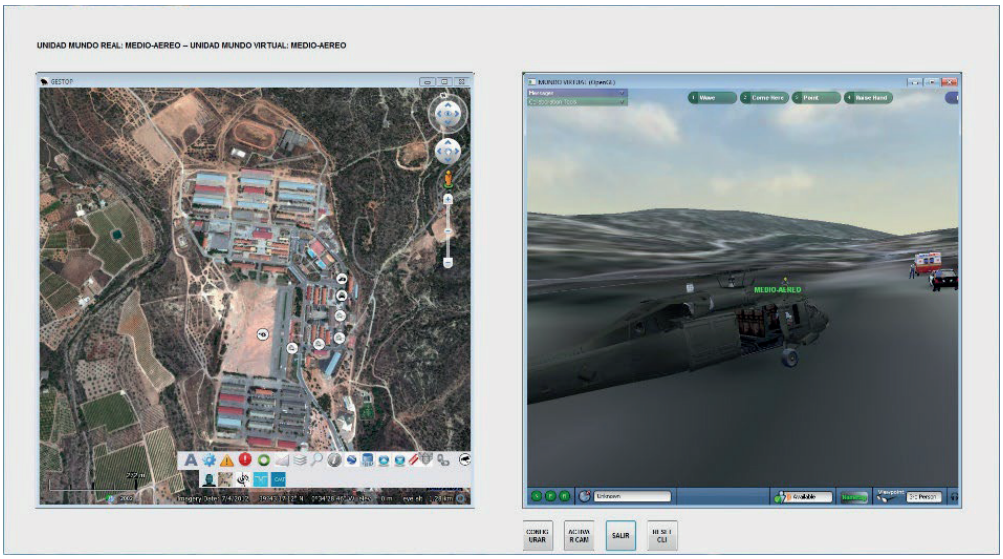


Figure 5. SIMTAC platform showing real Command and Control System and virtual world.

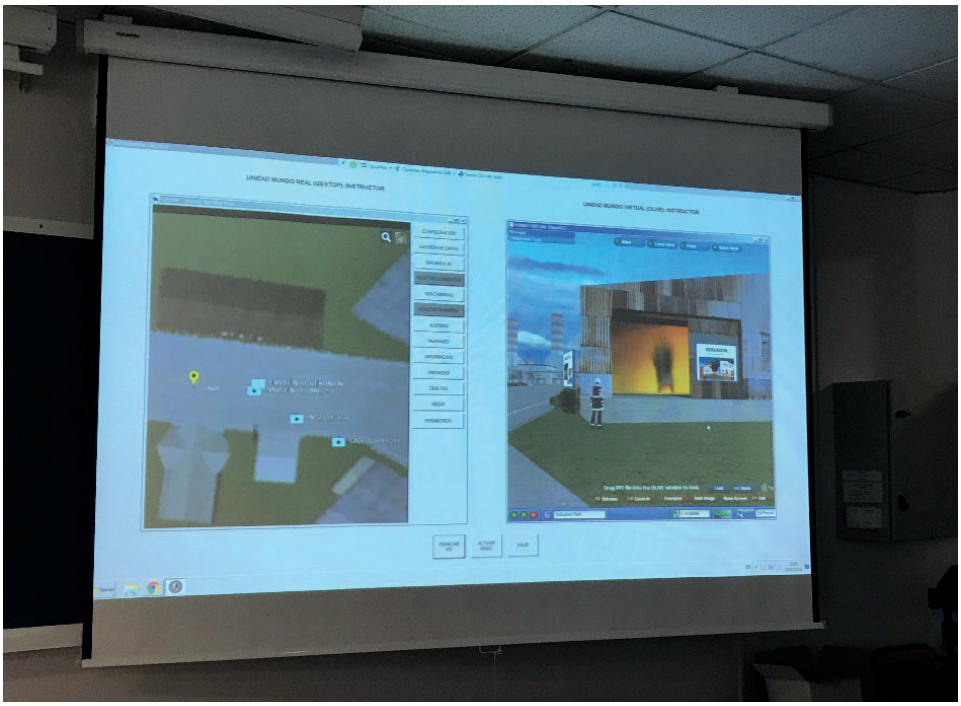


Figure 6. SIMTAC platform used during a course for the Valencia Firemen Department.

Subject 4: Virtual Reality Scenarios Descriptions

This subject describes the types of scenarios that will be carried out using the three VR platforms available in the Consortium for Subjects 5-8 in the curriculum. Subject 4 clarifies the link between the theoretical knowledge and its application in the daily work of the students.

The scenarios encompassed by Subject 5 are intended to be an introduction to the three VR platforms used in the ASSISTANCE project. The scenarios comprising Subjects 6-8 will be used for training in conjunction with the three demonstrator pilots that will be conducted in Türkiye (Subject 6), Netherlands (Subject 7), and Spain (Subject 8).

Subject 5: Simple Virtual Reality Scenarios

This subject is the first practical one and therefore will be taught through the use of the different VR platforms available in the Consortium. This will be carried out in various scheduled sessions whereby the FRs will access the VR platforms to get to know their features and accomplish different scenarios. In this subject, the simplest VR scenarios described in Subject 4 will be executed via remote sessions that will be agreed and scheduled between the FRs participants and the VR platforms providers.

Figure 7. ADMS scenario example.

Figure 8. ADMS training - commander giving commands using a 180-degree screen with ADMS.

For these subjects the VR scenarios described in Subject 4 for the different project pilots will be carried out via remote sessions that will take place during the project demonstrations in Türkiye, the Netherlands and Spain.

Evaluation Criteria

As stated earlier, the training curriculum is composed of several subjects, which have different types of content. The first four subjects are more theoretical and will be taught through an online learning platform (Moodle server) hosted by UPV. The last four subjects of the curriculum (5 to 8) will be more practical and will be taught through VR reality scenarios using the three VR platforms available in the Consortium. Due to these content differences (theoretical and practical), there will also be differences in the evaluation criteria assigned to each type of subject. The criteria will be based on documented legal requirements, standards and practices as well as opinions collected.

Evaluation criteria for the first four theoretical subjects

For the first four subjects, taught through the Moodle server, the Moodle evaluation features are used for evaluation. A Quiz Review for each subject is the main tool for evaluating the level of knowledge acquisition of the trainees. This

Figure 9. CNBOP Monastery Fire scene.

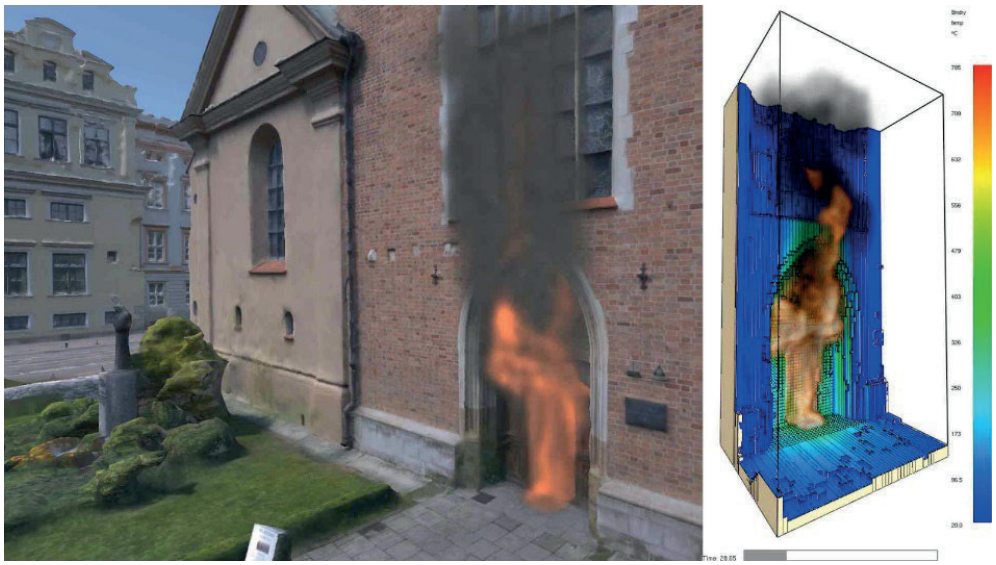


Figure 10. CNBOP Fire visualisation in the application.

Quiz Review is composed of 10 questions taken automatically and randomly by the system from a predefined question bank. The questions are based on the objectives (main, general, specific) of each subject. The quiz answers determine whether the learners understand what they are expected to learn, how the learning process is conducted, why it is important and how the learning outcomes can be applied to their daily work.

The evaluation criterion applied to all subject quizzes is that the minimum grade to pass each quiz must be a score equal to or higher than 8 correct answers. This grade configuration in the Moodle platform is described in Figure 11. The evaluation criterion also states that the trainee

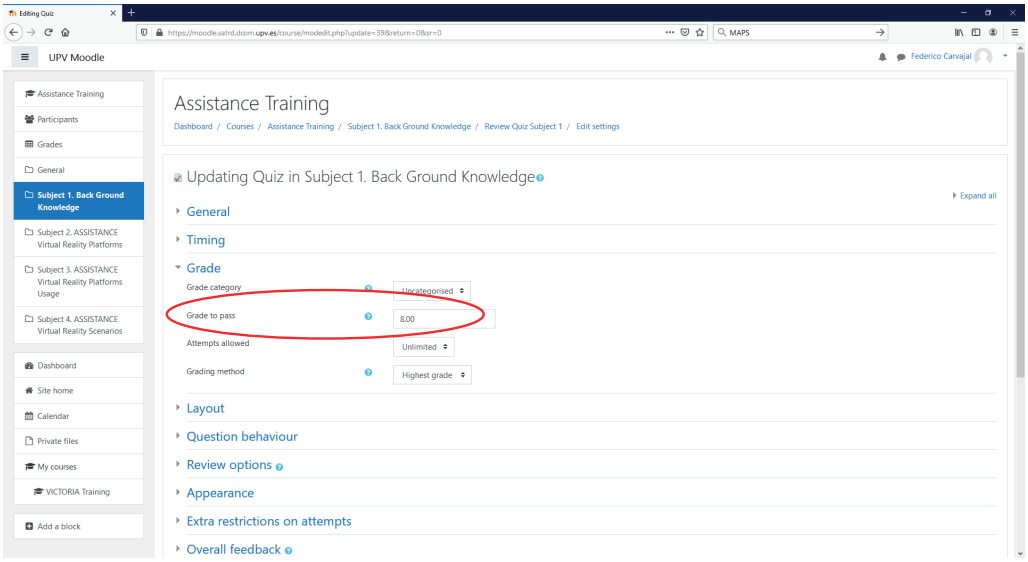


Figure 11. Grade to pass configuration.

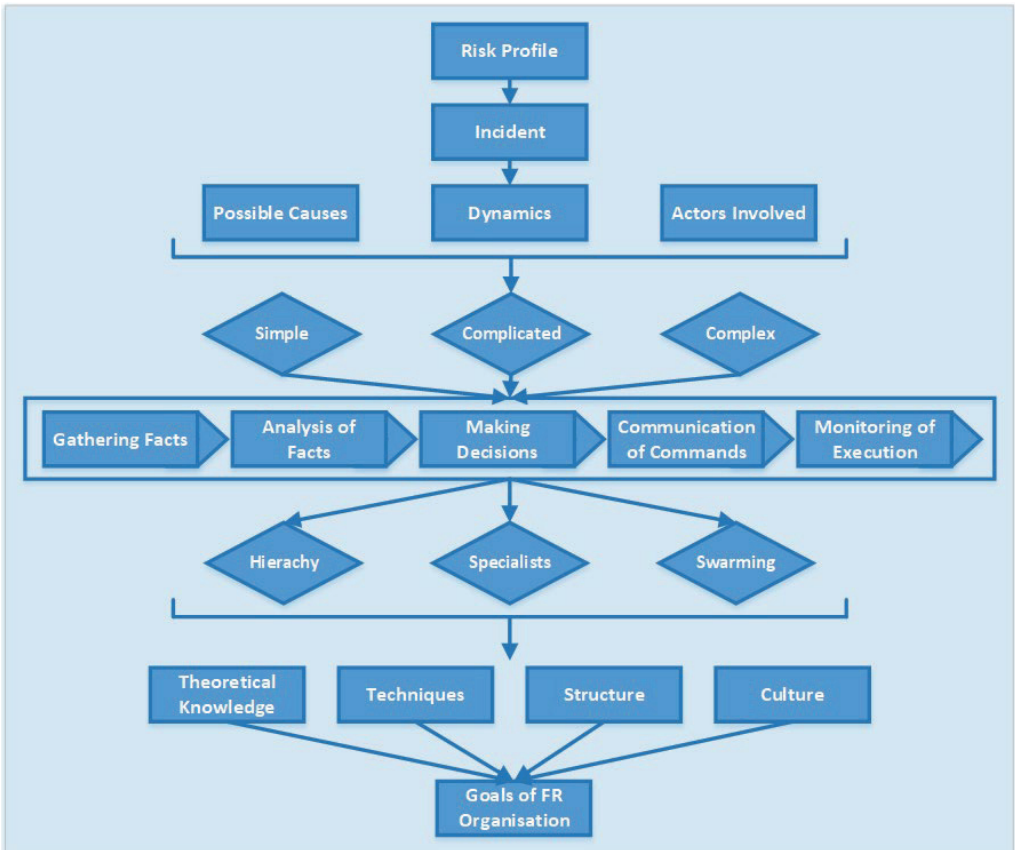


Figure 12. FADCM model used for evaluation of trainees of IFV VR platform.

will not be able to access the next subject unless a passing grade is obtained for the current Quiz Review. This restriction has been also configured in the Moodle platform in order to ensure the knowledge acquisition of all subjects.

Evaluation criteria for the practical subjects

Regarding the practical subjects (5, 6, 7, and 8) evaluation criteria will be based on the achievement of the objectives/goals of each scenario. As the practical subjects will be composed of different scenarios that will be performed using different VR platforms, these evaluation criteria will depend on the virtual platform used.

The evaluation criteria will assess the learner's capabilities for facing complex situations and will generally be based on the FADCM model. By combining the steps of the models in the literature for the training of the front-line crews, a model in which the decision is formulated in an order has been obtained by Groenendaal in 2015. FADCM is a model that places situational awareness especially in firefighting. FADCM stand for Facts (gathering of information), Analysis (analysing the problem), Decision, Communication (issues to order) and Monitoring (Figure 12) and it is a tool to generate qualitative evaluation criteria. The model shows step-by-step the abilities and limitations of first responders and how they can apply their knowledge in practice [10,11].

Discussion

The aim of the project is twofold: On the one hand the project will protect and help the different types of FR organisations that work together during the mitigation of large disasters (natural or man-made) and on the other hand ASSISTANCE will improve the FRs capabilities and skills for facing these kinds of events. For accomplishing the second main objective the training methodology has been defined and a stepwise tailored training curriculum has been composed, describing what to do, when and where to do it in terms of training activities and to what type of FRs each part of the curriculum addressed. The second part of the proposed training aims to improve the ability of FRs to confront complex situations, to provide them with advanced training based on VR and MR, customised to their organisational characteristics.

The ability of first responders to understand the situation and to accurately predict the flow of events in major disasters is defined in the literature as situational awareness. It is as crucial as finding the right balance between time, speed, and rigor when making decisions during emergencies. Establishing this balance is possible by simulating the situation before the actual disasters occur. While developing the curriculum, it is very important for pedagogical designs to use new technological constructivist approaches to simulate emergencies with a high probability of occurring [12-14].

In the literature, we see that most adult learners are highly motivated, problem-centred and task-oriented, that is they are more interested in learning about matters most relevant to their work. According to the literature adults are independent and self-regulated in their learning [3-5]. The use of VR techniques, Moodle platform and simulation scenarios in the project shows the constructivist approach of the newly developed curriculum that has been supported by the literature on the adult learning principles and technology-based curriculum perspectives.

Nowadays different FR organisations cooperate together to face large and complex disasters that in some cases can be amplified due to new threats such as climate change in the case of natural disasters (e.g., floods and wildfires, etc.) or the increase of radicalisation in the case of man-made disasters (e.g., arsonists that burn European forests, terrorist attacks coordinated across multiple European cities). The impact of large scale disasters such as these can have disastrous consequences for the European Member States and affect social well-being on a global level. Each type of FR organisation (e.g., medical emergency services, fire and rescue services, law enforcement teams, civil protection professionals, etc.) that mitigates the effects of these kinds of events is exposed to unexpected dangers and new threats that can severely compromise their personal safety. Therefore, the FRs' skills and capabilities have to be enhanced through tailored training based on new learning approaches adapted to each type of FR organisations' needs and using the advanced

VR training platforms via the European training network for FRs.

This paper highlights the main steps in the development of a novel methodology and training approach. This training programme includes a combination of lectures, virtual reality and scenarios exercises.

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Conflict of interest

There is no conflict of interest between the authors of this study.

References

1. Kumar V, Rus D, Singh S. Robot and sensor networks for first responders. IEEE Pervasive Comput. 2004;3(4):24-33. doi: 10.1109/MPRV.2004.17.
2. Benedek DM, Fullerton C, Ursano RJ. First responders: Mental health consequences of natural and human-made disasters for public health and public safety workers. Annu Rev Public Health. 2007;28:55-68. doi: 10.1146/annurev.publhealth.28.021406.144037.
3. Tretsiakova-McNally S, Maranne E, Verbecke F, Molkov V. Mixed e-learning and virtual reality pedagogical approach for innovative hydrogen safety training of first responders. International Journal of Hydrogen Energy. 2017;42(11):7504-12. doi: 10.1016/j.ijhydene.2016.03.175.
4. Lee K, Choi H, Cho Y. Becoming a competent self: A developmental process of adult distance learning. Internet and Higher Education. 2019;41:25-33. doi: https://doi.org/10.1016/j.iheduc.2018.12.001.
5. Cercone K. Characteristics of adult learners with implications for online learning design. Association for the Advancement of Computing in Education. 2008;16(2):137-59. doi: 10.1090/s0002-9947-2011-05358-4.
6. Kern DE, Thomas PA, Hughes MT. Curriculum development for medical education: a six-step approach. curriculum development for medical education: A six-step approach. 2009. 272 p.
7. UPV. Universitat Politécnica de Valencia. 2021. Available at: https://www.upvx.es/
8. IVF. Platform Crisis Management. 2021. Available at: https://platformvoorcrisismanagement.ifv.nl/editie02/welkom/?gclid=CjwKCAjw7J6EBhBDEiwA5UUM2s2C-VGeoPqq_QP2MAR-saoXv5M9zLDrQrYNrKXLfJeuBvvYSt8OVhoCm QwQAvD_BwE
9. CNBOP. Centrum Naukowo-Badawcze Ochrony Przeciwpożarowej. 2021. Available at: https://www.cnbop.pl/pl/szkolenia/szkolenia-cnbop-pib
10. Bomhof L. Experience says it all! Or not? Situation awareness on the fire ground. Master's dissertation. University of Twente; Netherlands. 2017. Available at: https://essay.utwente.nl/73492/
11. Groenendaal J, Helsloot I. The application of Naturalistic Decision Making (NDM) and other research: Lessons for frontline commanders. Journal of Management & Organization. 2016;22(2):173-85. doi: 10.1017/jmo.2015.31.
12. Gok K, Atsan N. decision-making under stress and its implications for managerial decision-making : A review of literature. International Journal of Business and Social Research. 2016;6(3):38-47.
13. Endsley M.R, Garland D.J. Theoretical underpinnings of situational awareness: a critical review. In: Situation awareness analysis and measurement [Internet]. New York: NJ: Lawrence Erlbaum Associates; 2000:3-32. Available at: https://www.sciencedirect.com/science/article/pii/S0360319916304013?casa_token=lzWw81_wMqwAAAAA:o2TgFlwbi9bc0090FnUZlXxztEAc03SbbW1raVN1vmQoGvit_5PR8Q0R0I151PPwvSZ_QTvKkqY doi: 10.1007/978-981-15-1010-6_2.
14. Salomon G. Novel constructivist learning environments and novel technologies: Some issues to be concerned with. Learning and Instruction. 1998;1:3-12. doi: 10.1016/S0959-4752(98)00007-3.