PEDAGOGICAL GUIDELINES

http://fight-ar.com/

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The FIGHTARS partners are: SPSCH - Pardubice High School of Chemistry (CZ), Estonian Academy of Security Sciences (EE), Fire Fighters Training School (LT), University of Zilina (SK), SCP Academy – School of Certified Professionals (CY), and SBG Dresden – Saxon Training Company for chemical and environmental professions (DEU).

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Contents

1. Introduction

Using modern technologies in training is en vogue. Education personnel is always looking for efficient and effective education that meets the wishes of learners and society, psychological and pedagogical insights using the latest technological possibilities. The technological possibilities applicable in training have increased exponentially and are expected to do so in the future.

Education is geared towards a future in which teaching personnel and technology work together to provide learners the knowledge and skills necessary for a carrying out professional tasks. A today's life without technology is unthinkable. Technology by itself influences how we live, work, and learn. Trainers play an essential role for a meaningful application of relevant technology which results in better learning results and higher motivated learners. These guidelines are for firefighter trainer to know about and to implement modern, digital media in training.

The use of modern media like Augmented Reality (AR)and 360° in firefighter's training is new ground. The fields of application are manifold:

- Rescue works (e. g. technical accidents, natural disasters)
- Fire brigade communication and collaboration
- Handling hazardous substance exposure
- Fighting fires and
- Other incidents like explosions.

The mission of the FIGHTARs project is:

Train current or future professionals in today's world to be prepared for tomorrows challenges by the tailor-made support of teachers and trainers through educational innovations.

At the start of the FIGHTARs project we assume that new technologies, such as Augmented Reality (AR) and 360° video, have the potential to make classroom and live trainings more effective, efficient, personal, qualitatively better, and more motivating for the individual learner and teams.

Augmented Reality is the enrichment of the visible reality with computer generated, interactive holograms for purposes like guidance and explanation of non-visible processes. To see holograms, specialised technology, like smart glasses (AR glasses), smartphones or tablets are necessary. The use of smart glasses allows that both hands are free during live training, when interacting with the glasses

360° video enables users to "dive into" a digital generated environment. It is used for the documentation of real environments and for the orientation of users in space. It represents a "simpler" form of Virtual Reality (therefore VR). Interactivity is created by the integration of buttons for accessing further information, such as videos, 3D objects, weblinks etc.

No or less experiences exist in using AR and 360° video in firefighter's classroom and live training.

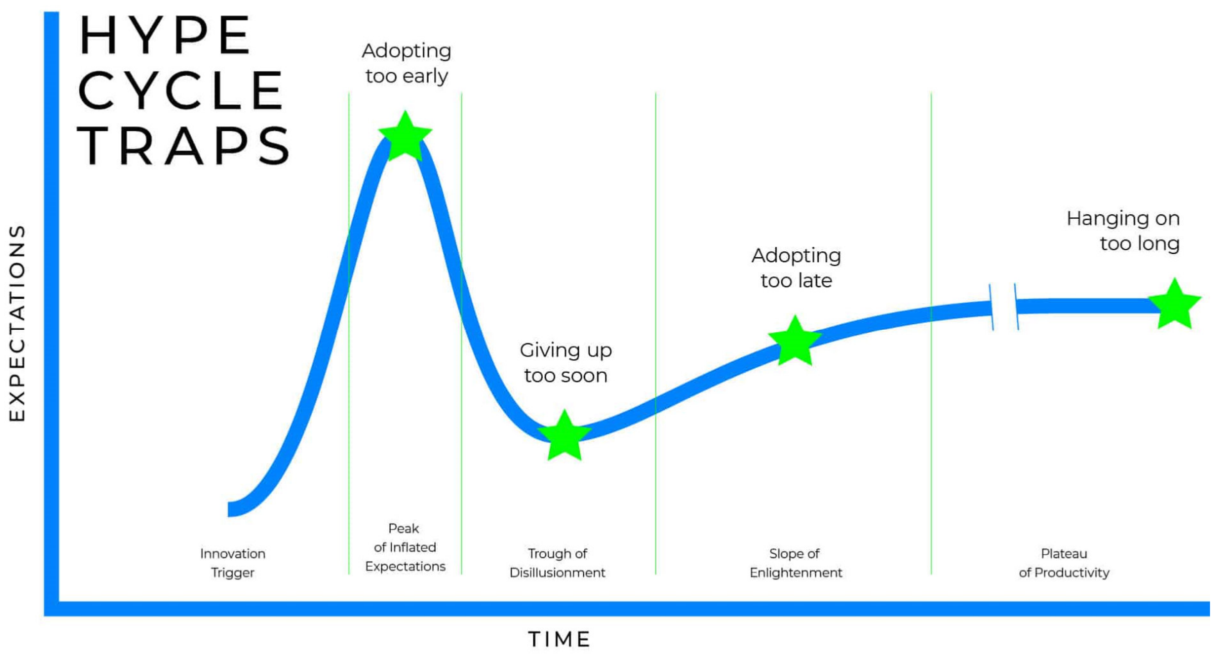
Figure 1. AR (left, marketing video) and VR (right, booth use) cases for existing applications

2. Hard and Software

The development of smart glasses hard- and software is very dynamic. The technology is itself is not a new one. In recent years, the glasses got more accessible due to advances in computing and in storage media. The bottleneck is the availability of suitable and professional content for specific working and learning environments such as for firefighting training.

Each new or modern technology surfs the hype cycle. [1] Boosted by high expectations, entering the period of disillusion and in the best case proving to be productive. The consulting firm Gartner publishes each year a hype cycle of new technologies. AR and VR were found on it until 2018. Both technologies graduate from the Hype Cycle from “a technology to watch” to one to use. [2] Gartner predicts “immersive workspaces“since then. **Immersion means embedding. AR and VR therefore embed the user in digital-enriched (AR) or completely digital-generated (VR) learning & training environments.**

Figure 2. Hype cycle



The industry is driven by economies of scale. Hardware gets over time lighter, more powerful, and more affordable. This normally results in more software capabilities due to faster processors. If the relevant software tools are available more applications are possible in a shorter amount of time.

Decisive factors for buying smart glasses are:

- Field of view
- Control options
- Refresh rate (for visualisation stability and latency)
- Weight
- Battery duration
- Operating System
- Price

Table 1: AR and VR headsets & 360° cameras (selection)

	Microsoft HoloLens 2 (AR)	Vuzix Blade (AR)	Oculus Quest 2 (VR)	HTC Vive Pro (VR)	Varjo XR-3 (VR)	Insta 360 One X	Ricoh Theta Z1	GoPro Fusion
Standalone	✓	✓	✓	✗	✗	✓	✓	✓
Field of view (horizontal)	43°	19°	89°	120°	115°	150°	360°	220°
Control	Gestures + voice	Touch pad	Controllers	Controllers	Controllers	Buttons	Buttons	Buttons
Refresh rate	60Hz	n/a	120Hz	90Hz	90Hz	n/a	n/a	n/a
Weight	566 g	93.6 g	503 g	1018g	980 g (with headband)	149g	182g	220g
Battery	2-3hrs	1-2hrs	2-3hrs	Via PC	Via PC	80 min	130 min	75 min
Operating system (compatibility)	Windows	Android	Android	Windows	n/a	Apple, Android	Apple, Android	Apple, Android
Price	3800 €	1200 €	350 €	660 €	1495 €	490€	1000 €	250 €

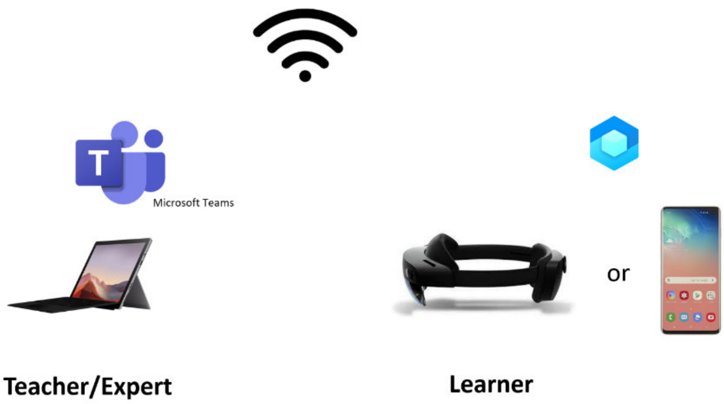
Note: Selected Augmented Reality (AR) and Virtual Reality (VR) glasses are presented as they enable to see 360° videos what a 360° camera record.

The application of Augmented Reality (preferably AR glasses, but also applicable to smartphones and tablets) is suitable for:

Figure 3. Augmented Reality options

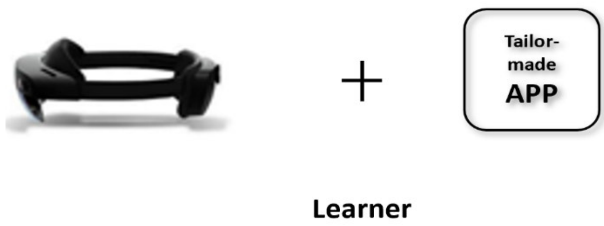
AR - Remote support (Remote Training): The audio-visual guidance of the expert to the learner, who wears the AR glasses (e. g. Microsoft HoloLens 2). The expert, a trainer or an experienced professional can say open a valve and annotate the valve with a digital generated hologram in the shape of an arrow. The required hard- software involves:

Figure 4. Augmented Reality Remote Support hard- and software



AR - Digital Twin: Interactive digital twins ("digital 3D copies") of objects enable firefighters to virtually interact with a e. g. am electrical car visualisation. The relevant hard- and software needed is AR glasses and app to insert the model (see figure 5):

Figure 5. Augmented Reality Digital Twin technology needs



3. Firefighters training experiences with AR and VR

The integration of smart glasses into firefighter's training is only a few years old. The current experience of VR dominates by number over AR applications. Limiting factors for AR and VR use were especially hard- and software related. It is still rather difficult to create the demanded levels of digitally reality in training to contribute to a measurable emergency preparedness and situational awareness of firefighters.

The known publications focus on the use of VR in research and training. No publication indicated a use of AR or VR in an actual incident.

The documented applications of **Virtual Reality [3]** in firefighters training:

- relates to simulating naturalistic training situations with safe training conditions, traceable actions and repeatable scenarios for debriefing and evaluation. [9]
- focus on the repetition and the training of work activities, which are too dangerous or too expensive. [4]
- favours the acquisition of operating procedures, but when uninstructed could lead to learning on rather trial-and-error basis. [5]
- provides also inexperienced firefighters or fire commanders with wide-ranging second-hand experience for prompt decision as well as safe and organized responses for actual fire situations [10]
- simulates real workplaces for occupational health and safety [10]
- focusses on building simulations with suitable content (e. g. XVR On-scene software) for computer screen (2D) and VR glasses (3D) for firefighters training [12]
- found effective for spatial presence and situational awareness of firefighters like incident commanders due to its higher level of realism [6] [7]
- is suitable for increasing the preparedness for incident response, decision making, team coordination and task level skills [8]
- is the choice in training for the "unexpected", by improving insights into new situations as well as increasing the motivation to train [9]
- is seen useful for remote-based training (some social cues might be lost) and examination [9]

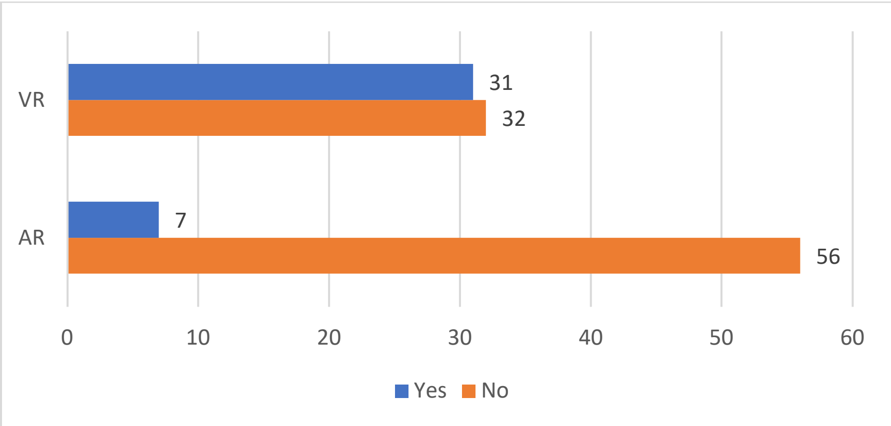
Augmented Reality application provide further or complementary benefits in firefighters training such as:

- enriching the visible reality with a digital layer for the real-time provision of technical information. This provision can involve a remote expert or is self-driven when integrating interactive digital copies ("digital twins") of real objects
- supporting the visualisation of spatial information, such as distances and heights [11]
- increasing data sharing across the command [11]
- hands-free use of digital provided information, when using smart glasses. Semi hands-free application includes the use of smartphones or tablets.
- filter and customize information presented to the incident commander [11]
- allowing regular verbal and non-verbal communication especially for the preparedness for urgent first aid [11]

4. Survey based firefighters training needs analysis

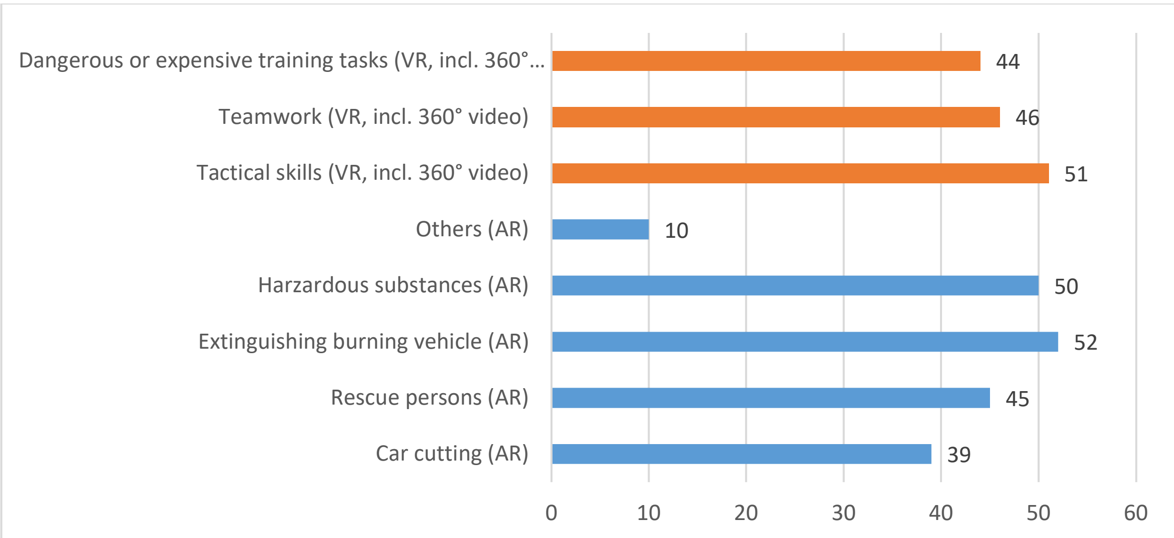
To assess existing and future training demands an online survey was carried among firefighter stations and firefighters training organisation in the Czech Republic, in Estonia, in Lithuania and in the Slovak Republic in April 2021. Almost half of the 63 respondents have already experience with Virtual Reality, but only around 10% worked before with Augmented Reality glasses or applications (see figure 6).

Figure 6. Experience with Augmented Reality (AR) and Virtual Reality (VR) in training



The dominating topic is the provision of technical and procedural skills by the means of interacting with a digital object or a digitally enriched real object. Augmented Reality is seen as suitable for the fields of extinguishing burning cars, such as electrical or hybrid cars, and cutting a crashed car open to rescue a person. Also, the training of procedures, when dealing with different hazardous substances is seen useful. In contrast, Virtual Reality and 360° video is seen useful in training when simulating very dangerous situations, and training teamwork and tactical skills (see figure 7).

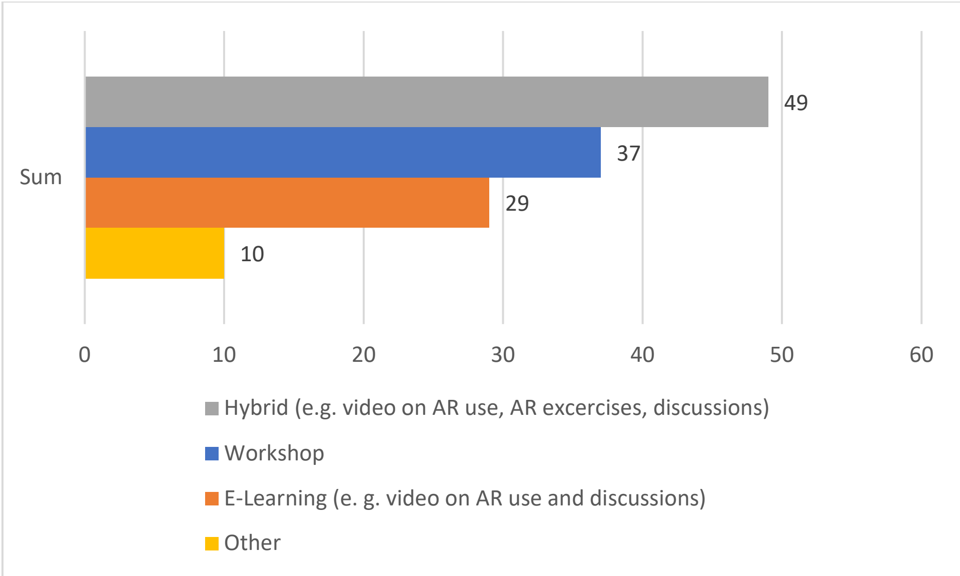
Figure 7. Preferred learning scenarios with Augmented Reality (AR) and Virtual Reality (VR)



The interest among learners and professional firefighters showed, that 80% are interested in AR and VR applied in different kind of training formats. 360° video use found by 75% suitable.

The largest approval obtained a mixture of on- and offline measures with almost 80% followed by practical workshops with around 60%. Pure online sessions are seen only by around 50% useful (see figure 8).

Figure 8. Preferred way of training provision



FIGHTARs focusses on the pedagogically sound application of Augmented Reality, 360° video and learning video application in firefighters training. They The survey results correspond with relevant and applicable learning theories.

5. Learning theories

The use of modern media into firefighters training must be integrative and complementary in the first place to be applicable. Pedagogical questions of modern media use are key. The FIGHTARs project asks:

How can we ensure a pedagogical added value of the teaching and learning scenarios when applying AR and 360° video in firefighters training?

Existing learning theories provide frameworks and models to develop suitable approaches for technology enriched theoretical and practical training.

Firefighters' training is currently a mix online, classroom and live-training. [12] In the classroom the provision of theoretical knowledge (regulations, chemistry etc.) is key. During live training the handling of equipment, experience with heat, time pressure etc. is key to gain the necessary knowledge and skills. Classroom and live training have already proven methods for development, carrying out and assessment. [12]. A live training can be resource-intensive (training personnel, specialized facilities, equipment, and well-planned scenarios) and hazardous for trainees (real temperatures, risk to fall) and environment (smoke, chemical wastes etc).

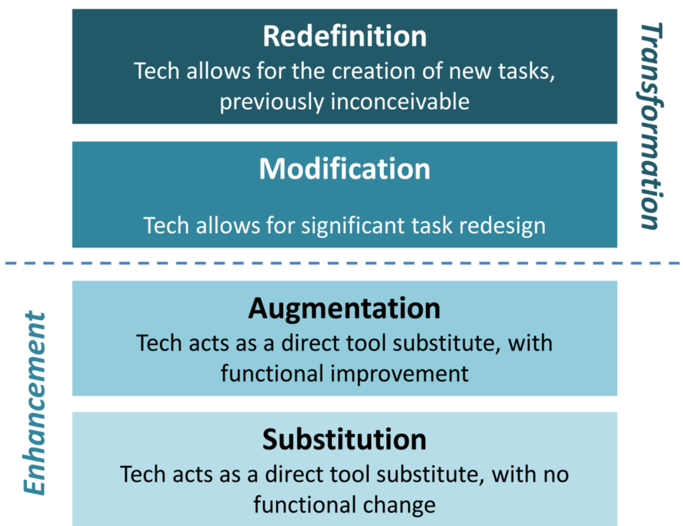
The use of AR and 360° will not replace classroom or live or their evaluation [8], but it has the potential to enrich both forms technically and pedagogically.

To successfully implement a new technology within practical training a four-step approach is recommended.

Step 1: Decision about augmentation or transformation?

New technology can have manifold impacts, ranging from a substituting or augmenting technology. If technology allows the redesign or the creation of new tasks the transformative level is reached. The **SAMR-Model** (**S**ubstitution, **A**ugmentation, **M**odification, **R**edefinition) provides a classification framework (see below figure 9).

Figure 9. SAMR model elements

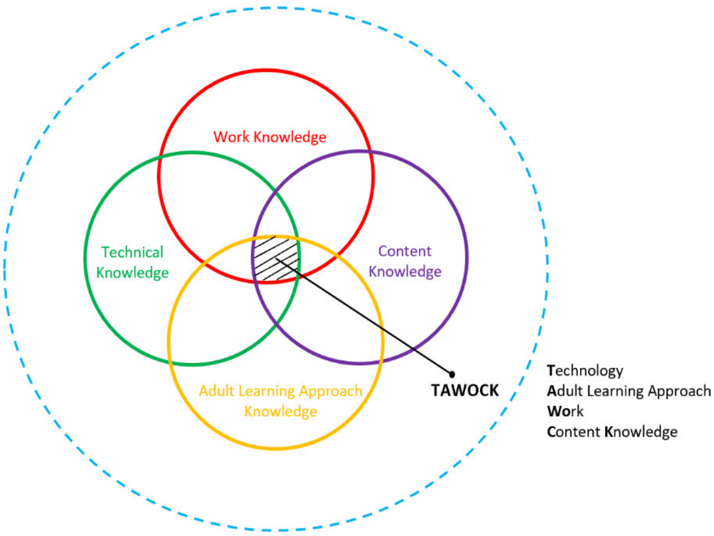


AR and 360° video augment an existing training environment.
Step 2: Decision on sound combination of work knowledge, appropriate learning approaches technology and content?

A trainer and trainee need integrated knowledge of following areas (see also figure 10):

• Working Knowledge– What practical competences are necessary to master a task and how AR and 360° video support learning?
• Content Knowledge - What lesson content does he or she want to offer with AR and 360° video?
• Andragogy Knowledge or Adult learning approaches – What are appropriate ways to support and facilitate teaching and learning when using AR and 360° video?
• Technology Knowledge- How should AR and 360° video used to achieve the learning goals?

Figure 10. TAWOCK model elements [13]



"TAWOCK" is a conceptional model for the relationships between work areas, content delivered, technology needs and learning approaches adapted. It provides a framework for planning and execution of classroom training and live training. It results in a technology-enriched and pedagogical effective provision of learning contents.

STEP 3: Decision on what are the learning objectives?

The integration of AR and 360° video in a specific lesson demands a careful description of the desired outcomes. They can reach from the provision of e. g. technical knowledge to the enrichment of communication and collaboration as a teaching method. The focus in practical training is for[1]:

a) AR rather on activities such as "**clarify**", "**carry out**", "**integrate**" or "**judge**".
b) 360° video rather on activities such as "**recognize**", "**recall**", "**summarize**" or "**classify**".

[1] See appendix 1 – clarification of learning objectives according to Blooms taxonomy.

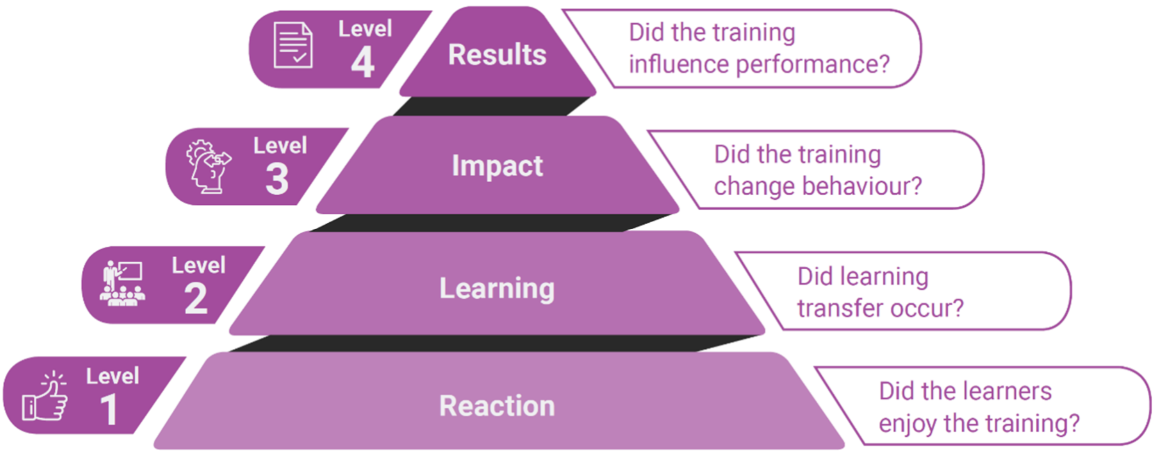
After the definition of the expected impact (augmentation), the integration of the relevant knowledge (TAWOCK) and the clarification of the learning objectives the enrichment of the relevant learning environment with the supporting communication and collaboration scenarios can be carried out.

By the completion of the classroom and/or live training the impact on emergency preparedness must be evaluated.

STEP 4: Evaluation of a training program

To evaluate learning sequences a four-step approach (see below and Appendix 3) can be applied. The single stages are independent from a learning perspective, e. g. positive feedback does not necessarily translate to effective learning, which in turn does not always lead to improved practice in the work setting.

Figure 11. Kirkpatrick training model [14]



There are different ways to evaluate different levels of training:

Level 1 – Collection of subjective information by end of session questionnaires

Level 2 – Observations by trainers on gained proficiency level, time to complete a task, number of errors, number of questions asked by the learners, skills test etc

Level 3 – Formal or informal assessment with measures built in for quality and comparability (e. g. examination situation after course in new situation)

Level 4 – Work based formal assessment of competence or practice, carried out in the workplace, or using evidence from work activity. An alternative is the written or verbal feedback from learners' supervisors.

6. Technology enriched learning scenario provision

The application of AR, 360° video and e-learning modules videos **enrich** and not replace eLearning, classroom, or live trainings. AR, 360° video and e-learning modules are designed to increase the firefighter's preparedness for live trainings by the provision of professional knowledge e. g. on how to handle the equipment.

The use of AR and 360° is favourable during classroom trainings. Learning videos can prepare or accompany classroom training. The application of e. g. AR (remote training) during live trainings must be tested. The application of AR on the way to an incident scene is thinkable scenario.

The application of AR and 360° can be tied to a single scenario or it can be used more versatile. The integration of an interactive visualisation (digital twin) of a crashed car is specific, in contrast to the use of AR Remote support (see page 7) for audio-visual support when dealing with a real car body in training.

For a pedagogical sound use in training specific **learning scenarios** are needed. Scenario-based learning involves real-world scenarios to create an immersive and relatable learning experience for learners. Learners are assigned to specific roles and face different problem situations. Herewith they obtain the demanded set of knowledge, skills, and competences. This way of training specifies roles, activities, resources, and relevant tools.

STEP 1: What educational challenge or problem AR and 360° video should solve in the four firefighter training institutions?

Provision of technical skills over distance (different hazards and car types)

Knowledge provision

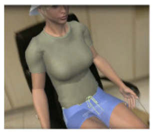
Better collaboration

Prep training (H&S)

Train dangerous situation upfront (elect. car)

Database access on the way to accident

STEP 2: Fields of application

SCENARIO	 *Car: Cutting*	 *Hazardous substances*	 *First aid*	 *Electrical car: deactivation battery*
TECHNOLOGY				
TARGET GROUP	Students	Students + „brigade leader“	Incident commanders	„Professionals“
PROVISION	Training + in fire truck to the event	Training	Training	Training

The selection of applications by internal experts in the FIGHTARs project and by external experts (survey) match. AR is seen suitable for extinguishing burnings cars (especially electrical and hybrid cars), cutting a crashed care open to rescue (injured) passengers. In addition, the handling of hazardous substances is a must. The indoor navigation in a building is a further scenario (e. g. by 360° video). During training different communication and collaboration scenarios (single person, in group) will emerge to train especially teamwork skills.[2]

STEP 3: Scenario development (combining STEPS 1+2)

The technology choices are intended to **enrich or augment** classroom and potentially live trainings. It is important to define for what working steps on which scenario and which way of provision (**TAWOCK[3] model**) AR and 360° video is used. AR should focus preferably on activities like to carry out or judge something, in contrast to 360° videos where the recognition, recalling and summarizing of knowledge is key.

Below are three TAWOCK-oriented lesson plans:

a) Extinguishing burning electrical car (classroom training)
b) Dealing with hazardous substances (classroom/live training)
c) Indoor navigation in the event of a fire (classroom training)

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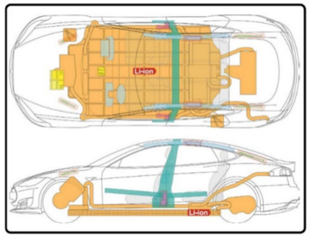
[2] Virtual Reality is preferable for training teamwork and tactical skills. It will be interesting to which extend AR use can train tactical skills also sufficiently, when having e. g. 1:1 scenario.

[3] See on page 13.

SCENARIO | EXTINGUISHING BURNING ELECTRICAL CAR (AR DIGITAL TWIN) | [CLASSROOM TRAINING]

TESLA MODEL S

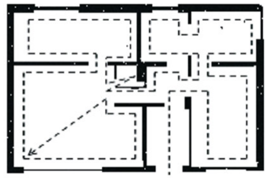


LEARNING CONTENT PHASE	WORKING STEPS (LEARNING ACTIVITIES)	TECHNOLOGY	COMMUNICATION & COLLABORATION	TEACHER ACTIVITIES
Analysis/Orientation (xx min) ("Clarify")	* Arrival to (virtual) incident scene * Analysis persons in danger * Analysis environment (close buildings etc.) * Analysis car type (e.g. Tesla Model S)	*Video *AR visualisation: Person in car *AR digital twin in set environment *AR digital twin with views battery package location etc.	*Learner-teacher (1:1), brigade leader (teacher) briefs on scene with latest information * Teacher follows over screen	* Verbal presentation scenario * Introduction AR glasses
Execution (xx min) ("Carry out")	*Selection extinguishing agent (e.g. water < 10m³, small fire ABC fire extinguisher) *Vehicle extinguishing (standard tactics+ equipment, re-ignition of high voltaage battery by sound of clicking, then white smoke and/or sparks + visible flames) *Ensure distance of min. 15m from other cars or buildings * Cooling burned battery for 24hrs+ to prevent re-ignition	*AR digital twin with proximity tracker (1m = 10 cm in visualation to create spatial under-standing) * AR digital twin with visible and audio signs of fire, high voltage, ...) *AR digital twin options cooling (e. g. water diving)	*Learner-teacher (1:1), teacher verbal support	*Verbal guidance, if needed
Assessment (xx min) ("Judge")	*Extinguishing burning car (time)	*Integrated quiz to follow measures	*1:1 evaluation performance in dialogue	* Carrying out dicussion/dialog

SCENARIO	HAZARDOUS SUBSTANCES (OIL SPILL) (AR REMOTE TRAINING)		[CLASSROOM/LIVE-TRAINING TRAINING]	

LEARNING CONTENT PHASE	WORKING STEPS (LEARNING ACTIVITIES)	TECHNOLOGY	COMMUNICATION & COLLABORATION	TEACHER ACTIVITIES
Analysis/Orientation (xx min) ("Clarify")	* Arrival to (virtual) incident scene * Analysis if persons in danger * Analysis environment pollution * Determination hazrdous substance(s)	*AR Remote training Stream (no programming) *AR Remote training Stream (no programming) *AR Remote training Stream (no programming) *AR Remote training Stream (no programming)	*Learner-teacher (brigade leader) (1:1)	* Verbal presentation scenario * Introduction AR glasses * Audio-visual instruction + support
Execution (xx min) ("Carry out")	*Use of spill containment (stop entering larger bodies of water) by bonnet barriers, sorbents *Collection of oil-water-mixture by various equipment * Temporary storage of mixture in tanks, re-serviors *Water treatment (case: major accident, low concentration of oil-water-mixture) *Disposal of pollutants (by specialists)	*AR Remote training Stream (no programming) *AR Remote training Stream (no programming) *AR Remote training Stream (no programming) *AR Remote training Stream (no programming) *AR Remote training Stream (no programming)	*Learner-teacher (brigade leader) (1:1)	* Audio-visual instruction + support
Assessment (xx min) ("Judge")	*Collection of pollutants (time, ...))	*Discussion on recorded remote-training session between learner and trainer	*1:1 performance evaluation	* Carrying out dicussion/dialog

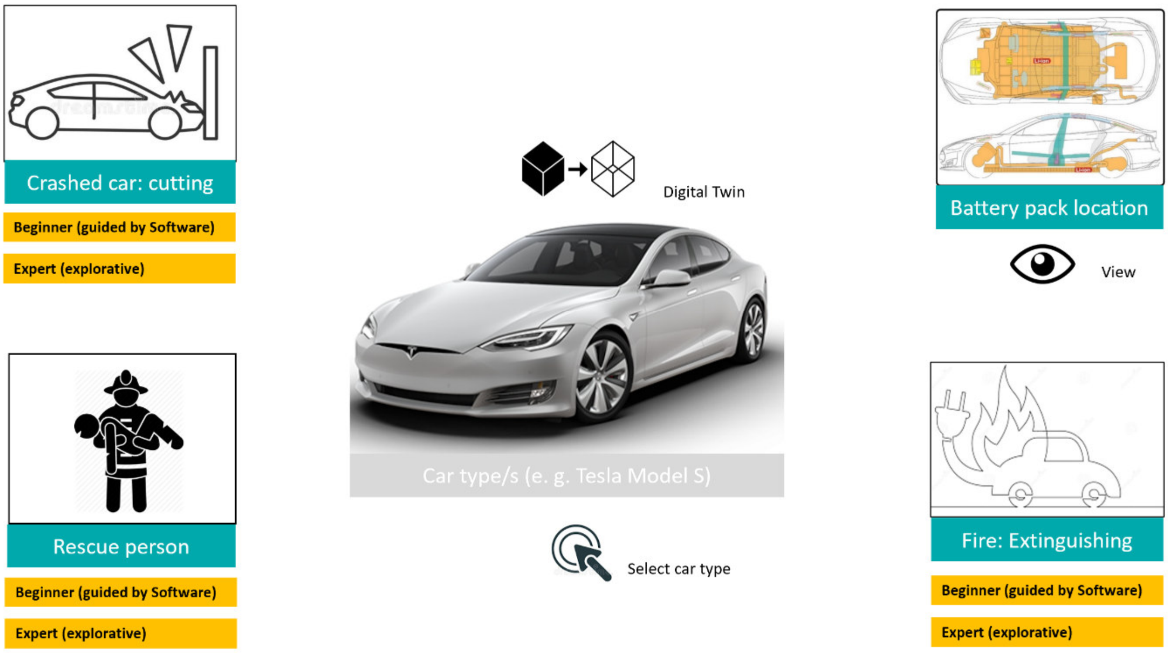
SCENARIO HANDLING INDOOR FIRES/INDOOR NAVIGATION (360° video) [CLASSROOM TRAINING]



LEARNING CONTENT PHASE	WORKING STEPS (LEARNING ACTIVITIES)	TECHNOLOGY	COMMUNICATION & COLLABORATION	TEACHER ACTIVITIES
Analysis/Orientation (xx min) ("Recognize")	* Arrival to (360°) incident scene * Analysis persons in danger and neighboring buildings affecte * Analysis kind of fire (where + color) * Analysis water hydrants location and hose line lenght	*360° video *360° video *360° video *360° video	Single learner	* Verbal presentation scenario * Introduction 360° video use
Execution (xx min) ("Recall")	* Selection extinguishing agent (e.g. water) * Analysis building indoor (e.g. door hot, door opens in- or outside) * Deciding on movement combustion hearth * Searching the combustion hearth * Building mapping * Rescue (of persons, animals)	*360° video *360° video + quiz on entering flat options *360° video + quiz on strategy reaching to fire *360° video + quiz on strategy searching fire *360° video on mapping options (search) *360° video on rescue operation	Single learner	*Support if requested
Assessment (xx min) ("summarize")	*Extinguish combustion hearth, rescuing people, animals (time, ...)	*Integrated quiz to follow measures	*Evaluation of quiz results and overall performanc by trainer	* Carrying out dicussion/dialog

The digital twin of handling an electrical car, with a beginner (guided) and expert (explorative) mode should inform interactively more about (after arriving the incident scene[4]):

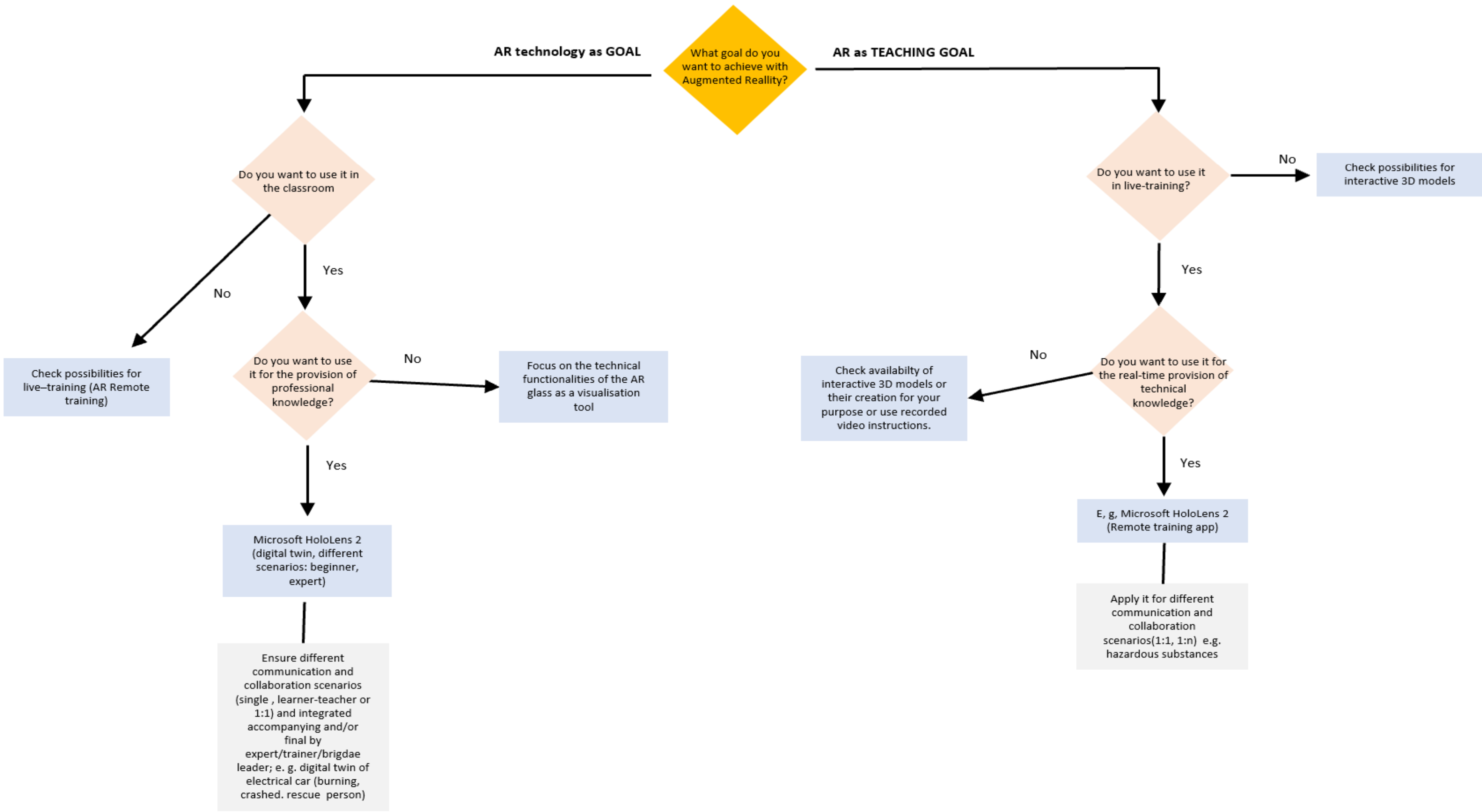
a) the selectable car types,
b) the battery pack location,
c) how to extinguish it (choice of extinguish agent, water hose length, safe distance, sound of battery),
d) cutting car open after crash to rescue a person and
e) rescue a person in the case of unconsciousness and/or injury[5]



The decision-making on HOW and WHERE to use selected Augmented Reality scenarios (Remote training, digital twin) in trainings (classroom and live-training) visualizes the following flow chart.

[4] Scene description by text, pics, or video.
[5] The rescue scenario could be also carried by using QR codes in a dummy in classroom or live training.

Augmented Reality use in trainings



7. Learning labs for immersive training in firefighting

A “Learning Lab” is a means aimed at inspiring and guiding teachers, trainers, and firefighters’ students to implement ICT-rich education at their own school or training institute. In addition, research and knowledge is gained in the field of learning and teaching with ICT in a “Learning lab”. The acquired knowledge is shared with everyone working in the field.

A “Learning Lab” is not only a physical place where firefighter teachers and trainers gain knowledge and experience with new technologies in education, but it is also a virtual place to acquire and share knowledge. “Learning Labs” also focus on the process and attitude when it comes to learning to teach with ICT.

a) Learning labs: Development plan

The plan should incorporate

- a *vision* (“How education can influence to world of tomorrow?”),
- a *strategy* (“How we will achieve it”?) and
- a *mission* (“What are our core values?”, “How do we want to deal with learners and employees?”)

Within the FIGHTARs project we define the strategy as to set up learning labs. This involves the following steps:

- **Understand** (What is known? What does fit in the mission and vision of planned learning labs? For whom, why, what, and how the learning labs are developed? (incl. educational questions)
- **Explore** (What scenarios and training settings are suitable? Which digital prototypes should be built and tested?)
- **Materialize** (What the user liked? What did they not like? What should be altered? How to bring the final product to more users?)

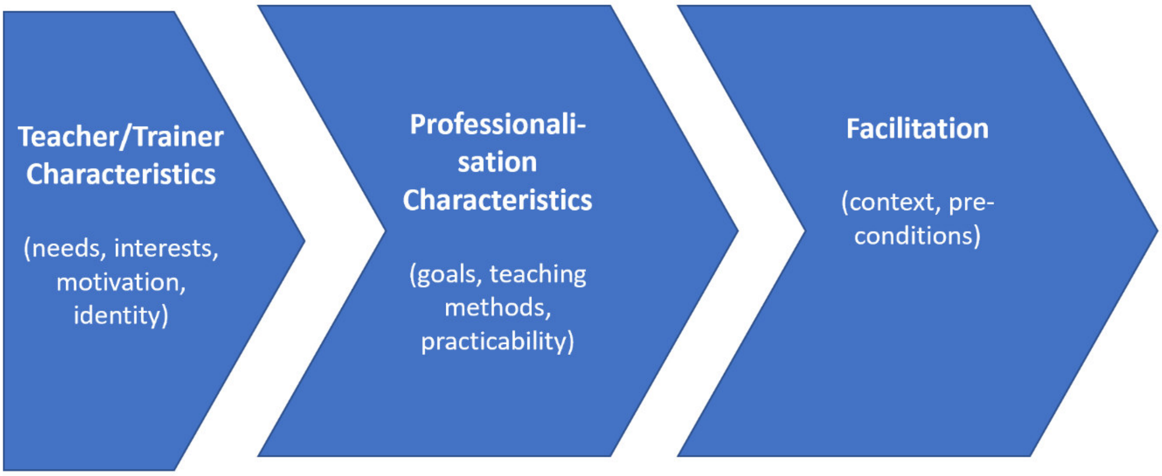
b) Decision making

Key is to make explicit choices on the professionalisation of teachers/trainers ICT skills by the school board. Options are:

- information meetings,
- short courses and trainings,
- coaching and peer review,
- participation in a network and
- external trainings.

c) Professionalisation of teachers/trainers (see figure 12)

Figure 12. Flow chart professionalisation of teaching personnel in 3 steps



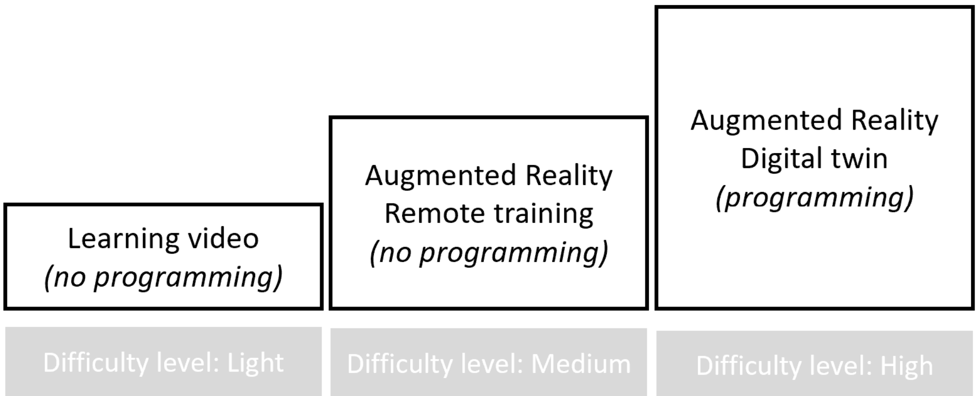
d) Content development for trainings

The enrichment of existing trainings with modern digital media is aimed, instead of creating new qualification offers in the first place. Key is the description of the specific educational problem or challenge where the new technology or technologies can help with.

For training purposes, for the handling with a crashed car (no electrical car) learning videos (preferably classroom training) as well as Augmented Reality Remote Support (live trainings) are applicable separately or in combination. Both options do not require any software programming capabilities from the trainer in the content creation phase.

The software programming of an interactive digital twin would only make sense for training dangerous or expensive scenarios, like a burning electrical car. This requires from the trainer to contact a software programmer or use existing visualisations.

Figure 13. Visualisation "staircase" (media creation)



8. Recommendations

The FIGHTARs project brings Augmented Reality and 360° video to firefighters training in order to support spatial learning and increase situational awareness by the provision of especially technical knowledge. AR and 360° video do not replace but enrich existing classroom and live trainings by focussing on the pedagogical added value (pedagogy > technology). They are expected to be strongly complementary to existing experiences with Virtual Reality in firefighters training.

The preferred scenarios (electrical car: burning, crashed, person rescue; handling hazardous substances, indoor navigation in the event of a fire) are possible to implement. For a pedagogical sound-application the TAWOCK (Technology-Adult Learning–Work & Content Knowledge) model is suitable. The seamless implementation will enrich the currently rather general published experiences about AR and 360° video use in firefighters training with real use cases. The potential is there to also test the feasibility of e. g. AR remote training during selected live trainings.

A structured way of facilitation for integrating AR and 360° in theoretical and live training is needed. The learnings among the four planned centres of immersive firefighters training shall be shared over different means of communication to identify best practices, which are transferable and therefore scalable. This ensures a further use of AR and 360° in firefighters training.

9. References

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APPENDICES

APPENDIX 1: Formulation of learning objectives (Bloom)

APPENDIX 2: Scenario planning template

SCENARIO		(CLASSROOM OR LIVE TRAINING)

LEARNING CONTENT PHASE	**WORKING STEPS (LEARNING ACTIVITIES)**	**TECHNOLOGY**	**COMMUNICATION & COLLABORATION**	**TEACHER ACTIVITIES**
Analysis/Orientation (xx min)				
Execution (xx min)				
Assessment (xx min)				

APPENDIX 3: Evaluation

LEARNER FEEDBACK (CLASSROOM TRAINING AND LIVE TRAINING)

Scaled questions (suggest 5-point scale).

Question	Yes/Very much/ A lot				No/ Not at all
Did you find the session/course well organised and structured?					
Did you find the process straightforward to follow?					
Do you feel that your understanding of the topic has increased?					
How satisfied are you with your performance of the tasks?					
How confident are you that you can use what you have learned at work/in an independent project?					
Did you find it easy to recover from mistakes or misunderstandings?					
Did you find it easy to get answers to any questions you had?					
Was the technology (AR, 360° video) comfortable to use?					
Was it easy to find your way around the technology?					
Was it easy to move from one step to the next using the technology?					
Did you feel that the technology helped you learn?					
…					

OBSERVATION (CLASSROOM TRAINING AND LIVE TRAINING)

This template is for multiple learners for one major activity or task.

Activity													
Observer													
Name	**Qs**	**Help**	**Step 1**		**Step 2**		**Step 3**		**Step 4**		**Total**		**Level**
			Time	Err	Time	Err	Time	Err	Time	Err	Time	Err	

Note on columns:

- Questions – these are questions seeking to clarify process, get feedback etc. Ignore ‘interest’ questions e. g. asking for more advanced knowledge.
- Help – where the learner is stuck and needs the trainer’s help to move on.
- Time – to complete the step.
- Errors – number of obvious errors at end of step.
- (If there are no clear breaks in the process, ignore the intermediate steps).
- Level – decide on a scale e.g. 1-5 each with clear criteria (e.g. novice-to-expert definitions, see end of document).

Comments:

Add your comments e. g. about learners’ engagement and ‘flow’, and for technology-mediated groups their ease of use of the technology.

ASSESSMENT (CLASSROOM TRAINING AND LIVE TRAINING)

This is a rough outline as there may be other requirements e. g. if it is contributing to certification.

Learner:

Assessor:

Date of assessment (and how long after training):

Description of task or activity:

EQF/national level if relevant:

Success criteria (these will normally be, or be an expansion of, the learning objectives):

Criterion	Achieved	Comments

For the task overall, what level of proficiency did the learner reach? (Use a scale with clear description – see the example at the end).

LIVE TRAINING OBSERVATION.

Provide a clear description of the task, and a short set of success criteria. These could be the same as the assessment criteria, or they may be 'scaled up' for proficiency in the workplace.

Questions for supervisor:

Are there any criteria that the learner has difficulty meeting?

How well does the learner perform the task/activity as a whole? (Suggest using a 5-point scale such as novice to expert, with a short description of each level – see end of document).

How confident is the learner in doing this task unsupervised? (scale)

How confident are you that the learner can do this task unsupervised? (scale)

Any additional comments? Is there anything else that we could have done in the training to improve the learner's level of proficiency?