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Planning the Use of Augmented and Virtual Reality for Vocational Education and Training

A Practical Guide

Federal Institute for Vocational Education and Training

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Authors
Dr. Lutz Goertz
mmb Institute

Thomas Hagenhofer
Central Committee for Vocational Education and Training in Print and Media, ZFA

Christian Dominic Fehling
University of Wuppertal

Editor
Eva Hanau
Federal Institute for Vocational Education and Training (BIBB)

Layout
Christian Dominic Fehling
University of Wuppertal

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Contents

Glossary of terms: Design and Didactics

Affective Learning Objectives
Learning goals in the area of feelings, attitudes and values. They are trained via reflection, networking and practical application (affective = emotive). [11]

"Three Domains of Learning – Cognitive, Affective, Psychomotor". The second principle. Leslie Owen Wilson

Authoring Tools
Tools that help authors of (educational) content create material, e.g. for the use in AR/VR. Authoring tools work on an abstract, user friendly layer which compensates the IT and 3D expertise normally needed to create AR/VR content. [40]

Kaskalis, Theodore H., Theodore D. Tzidamis, and Konstantinos Margaritis. "Multimedia authoring tools: the quest for an educational package." JOURNAL OF EDUCATIONAL TECHNOLOGYAND SOCIETY 10.3 (2007): 135.

Classroom-based Teaching / Learning
Is held at a set time and place, and is conducted by an instructor in an organized manner utilizing a lesson plan. [16,28]

Collaborative Learning
A situation in which two or more people learn or attempt to learn something together. [38]

Communication Skills
The knowledge of effective and appropriate communication patterns and the ability to use and adapt that knowledge in various contexts. [34]

Emotional Activation
Evoking an emotional response from the user, e.g. empathy, joy or fun, within a virtual environment. [16]

Fredrickson, Barbara L. "The role of positive emotions in positive psychology: the broaden-and-build theory of positive emotions." American psychologist 56.3 (2001): 218.

Empathy Learning
Learning to cultivate empathy (the ability to share someone else's feelings and experiencies). [39]

Employability Skills
The skills which enable people to gain, keep and progress in employment, including skills in the clusters of work readiness and work habits, interpersonal skills and learning, thinking and adaptability skills. [30]

"Terms of the German VET system". Federal Institute for Vocational Education and Training (BIBB) - Germany

Game-based Learning (GBL)
Game based learning is a type of game play that has defined learning outcomes. Through experimentation, learners actively learn and practice the right way to do things. [27,29]

Prensky, Marc. "Digital game-based learning." Computers in Entertainment (CIE) 1.1 (2003): 21-21.

Gamification
The combination of immersive learning media and game-based learning offers particular potential because the emotional involvement and motivation of learners receive an additional boost. This is especially true of younger target groups. [13,37]

Immersion
A perception of being physically present in a non-physical world. This is created by surrounding the user of the VR system in images, sound or other stimuli that provide an engrossing total environment. [6,16,21]

Immersive Media
Media which allows users to reach a state of immersion in computer-generated environments. The world thus technically constructed is then perceived as being real to a greater or lesser extent. [6,9,11,14]

Industry 4.0
Combines production methods with state-of-the-art information and communications technology that allows to manufacture products based on the individual needs of customers. [31]

"Industrie 4.0". Federal Ministry of Economic Affairs and Energy, Germany

Interaction Skills
The general ability to interact with the external world to accomplish a task. A typical interactive task requires the person to look for relevant information and choose the right actions. [34]

Labilization / Sensitization
Teaching specific learning content and skills through emotional experiences. [28]

Learning Scenario
An instructional design model for a given subject and a given kind of situation that defines what learners and other actors should/can do with a given set of resources and tools. [8,18,20,24,28,30,32,34,36,38,40]

"Pedagogical scenario". EduTech Wiki

Motor Skills
Relationship between cognitive functions and physical movement, as demonstrated by fine or gross motor skills and the learning of coordinated activities.[22,24,26,38]

Professional Competencies
Expert skill/knowledge in a particular field. The proven or demonstrated individual capacity to use know-how, skills, qualifications or knowledge in order to meet the usual, and changing, occupational situations and requirements. [30,32]

"Terms of the German VET system". Federal Institute for Vocational Education and Training (BIBB) - Germany

Serious Game
A serious game or applied game is a game designed for a primary purpose other than pure entertainment. [25,27,29]

Simulation
The (digital) imitation of a situation or a process. [23,25,26,37]

Social Competencies
Social, emotional, cognitive and behavioral skills needed for successful social adaptation.[7,34,37,38,39]

STEM
A broad term used to group together the academic disciplines "Science, Technology, Engineering and Mathematics" (STEM), which is typically used to address an education policy or curriculum choices in schools. [32]

Taxonomy
The classification of something. [11]

Training Dummy
A (digital) model or replica of a human being. [24,38]

Vocational Education and Training (VET)
The training in skills and teaching of knowledge related to a specific trade, occupation or vocation in which the student or employee wishes to participate. [6,32]

"Glossary:Vocational education and training (VET)". Eurostat

Glossary of terms: Technology

180° / 360°
Used to describe the viewable panorama in a VR application, e.g. only in front of (180°) or around (360°) the user. [34]

3D
Meaning three-dimensional (having three dimensions) for example a box with width, length and height. [6,20,38]

3D-Models
Digital objects defined by geometry, materials and animations. [9,17]

3D-Printing
The construction of a three-dimensional object from a CAD-Model or a digital 3D-Model. [9,41]
"3D printing scales up". The Economist. 5 September 2013.

Assistance Systems
Digital assistance aims at supporting users in all possible situations via intelligent and adaptive technologies. [7,19,22,29,36]

AR/VR
See Augmented Reality (AR) and Virtual Reality (VR) respectively. [6,8,11,16,24,28,30,32,34,36]

Augmented Reality (AR)
Overlaying the visible natural world with a layer of digital content, which happens in real-time, is correctly aligned with the real world and is interactive. [6,20,26,37]
Azuma, Ronald, et al. "Recent advances in augmented reality." IEEE computer graphics and applications 21.6 (2001): 34-47.

Avatar
The virtual representation of an user in a virtual environment, most relevant for aspects of immersion and presence as well as social AR/VR settings. [16,26,35]

Building Information Modelling (BIM)
Process involving the generation and management of digital representations of physical and functional characteristics of places. [9]
British Standards Institution (2019) BS EN ISO 19650, London: BSI

Computer-aided Design (CAD)
The use of computers to aid in the creation, modification, analysis, or optimization of a design. [9]

CAD-Data
Data necessary within the scope of product development. [9,28]

Controller
Input devices used for manipulating and/or interacting with virtual objects and environments. [17,22,24,26,36]

Degrees of Freedom (DoF)
The number of ways an object or user can move in a 3D space. The first three degrees refer to the rotational movement (3 DoF), whereas the addition of another three degrees refers to translational movements (6 DoF). [20,26,28,34,38]

Digital Twin
A virtual representation that serves as the real-time digital counterpart of a physical object or process. [7,20,28]
Elisa Negri (2017). "A review of the roles of Digital Twin in CPS-based production systems". Procedia Manufacturing. 11: 939–948.

Gartner Hype Cycle
Provides a graphical depiction of a common pattern that arises with new technologies or other innovations and enables the maturity and potential of a technology to be identified. The five key phases of the Hype Cycle are Innovation Trigger, Peak of Inflated Expectations, Trough of Disillusionment, Slope of Enlightenment and Plateau of Productivity. [6]
Blosch, M., and J. Fenn. "Understanding Gartner's Hype Cycles." (2018).

Haptic Feedback
Haptic technology simulating the sense of touch, for example through the sensation of pressure. [6,22,24]

Head-Mounted-Display (HMD)
A set of goggles or a helmet with tiny high-resolution monitors in front of each eye to generate images that the viewer perceives as three-dimensional. [6,9,26,36]

Inside-out
A method of tracking commonly used in VR, specifically for tracking the position of head-mounted displays and accessories, where the camera or sensors are located on the device being tracked. [22,24]
"Inside-out tracking". XinReality, Virtual Reality and Augmented Reality Wiki

Mixed Reality (MR)
A spectrum ranging from real to virtual environments, where augmented and virtual reality can be located on. [9,29]

Motion Sickness
A very small proportion of users develop symptoms such as dizziness, comparable to sea sickness. This problem has been alleviated thanks to advances in display-technology and optimized software. [17]

PC-based VR
Virtual Reality using a – generally powerful – computer. [10]

Photogrammetry
Photogrammetry is a measuring technology for obtaining information about physical objects and the environment through the process of recording, measuring and interpreting photographic images and patterns of electromagnetic radiation. [9]

Room-scale
A tracking paradigm that allows users to move freely within a room-sized AR/VR environment. [10]

Standalone VR
A HMD with built-in computing capabilities, Inside-Out-Tracking and batteries allowing for untethered AR/VR experiences. [10,17]

Tactile Input
Includes light and firm touch and the discrimination of different textures. [22,24]
"Tactile Input". A sensory life

Tracking
Tracking of users in virtual or augmented environments, e.g. with external trackers or inside-out tracking. [22,24]

Virtual Reality (VR)
Virtual Reality places users in another virtual location, entirely occluding the user's natural surroundings. [6,20,21,22,24,26,39]

Voice Assistance
A non-tangible user interface that allows hands-free operation of a digital device. [36]

1 Introduction

The aim of this guide is to provide initial assistance in the use of so-called **Immersive Media**, like **Augmented Reality (AR)** and **Virtual Reality (VR)**, in **Vocational Education and Training (VET)**. It uses actual practical projects as a basis to answer the following questions.

- For which purposes is the use of **AR/VR** worthwhile in education and training practice?
- Which technical, organisational and content-related aspects should be considered when planning and designing AR/VR projects?
- Which learning objectives can be addressed with the help of new learning technologies and which didactic methods are suited?
- What are typical use cases for AR/VR in TVET, and how can these be realised?

This publication is based on the project *"Identifying Didactic Concepts – Community of Practice for Learning with AR and VR (COPLAR)"*, which was funded by the German Federal Ministry of Education and Research (BMBF) in 2020. The results of this project were initially presented in a German publication* and have now been adapted for an international audience.

Virtual Reality left the **Gartner Hype Cycle** in 2018. Augmented Reality ceased to be listed in the market research company's prognosis one year later**. This means that these technologies are deemed to have come to maturity several years earlier than was forecast. Such technology was driven forward by the gaming industry and was integrated into education more rapidly than expected. Nevertheless, so-called immersive media are still a long way from becoming standard in VET.

> *"We really need to start doing something with virtual reality!"*

Perhaps this sentence is familiar to you. Using AR or VR has become more of a matter of course over recent years. VR is used to explain products at trade fairs and other events. Those undertaking the *"Time Ride"* attraction in Cologne are able to put on **Head-Mounted-Display (HMD)** and experience the city centre in 1910 from the perspective of a moving tram. And virtual reality has long since become an established part of the entertainment and games sector.

It is therefore only logical that AR and VR applications are used to stimulate the learning enthusiasm of trainees. You can be sure of achieving a *"wow"* effect. The three-dimensional (**3D**) representation of objects exerts a fascinating impact, and full **Immersion** into a virtual world also transforms learning into an emotional experience.

One questions emerges, however. Under which circumstances does the use of AR/VR for learning purposes really make sense? Fascination may dwindle after the third or fourth use of the same learning scenario. This might lead you to wonder: *"Could I not have achieved the same impact if I had imparted the material as an e-book, in a webinar or on the board via a face-to-face classroom setting?"*.

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* For more information: https://www.social-virtual-learning.de/wp-content/downloads/210225-Coplar-Leitfaden_final.pdf (german)

** For more information: Bozorgzadeh, Amir: In 2018, VR stopped "having potential" and started being real. www.venturebeat.com/2018/10/09/in-2018-vr-stopped-having-potential-and-started-being-real/

The implementation of AR/VR-based learning can prove to be an especially suitable approach if barriers to knowledge transfer or competence development exist within conventional learning and where the use of technology enables these to be overcome, thereby providing an added value for teachers and learners. This applies to the following five areas in particular.

Visualisation of and risk-free interaction with machines and manufacturing plants
Learners often find it difficult to connect the abstract presentation of a process or of a component with occupational practice. This is an area in which virtual learning can help to make the mechanisms and interaction of machines and manufacturing plants directly visible. In a certain way, the well-known concepts of the *"transparent machine"* and the **Digital Twin** are expanded in the form of additional didactic methods such as reduction, commentary and enrichment via extra information. The AR/VR application then constitutes a link between a simulation and the machine itself. The machine remains present in its specific shape and, depending on the work situation, is supplemented by additional pieces of information and by data elements. The machine or plant becomes accessible for learners and can be examined in a risk-free and exploratory manner.

Non-trainable situations and behavioural training
In certain areas of work, for example in the fields of healthcare or in disaster and accident prevention, situations may arise which are nearly impossible to recreate for training purposes, or only at considerable cost. Immersive media can help prepare employees also emotionally for such interventions. Realistic representation of these situations is able to trigger changes in behaviour whilst training is still ongoing. These modifications will otherwise only occur as through experience gained in professional practice.

Direct application in the production process in the form of Assistance Systems
Augmented reality provides a good foundation for providing direct support to production employees. During the work process, staff receive assistance in the form of instructions or hints. This allows induction phases to be shortened or enables tasks that are rarely performed to be executed more rapidly.

Acquisition of Social Competencies and ethical action through immersion
The significance of immersive media for so-called soft skills has been continuously growing. Whereas technical tasks once formed the main focus of attention, opportunities for authentic visualisation of decision-making situations and interactions with other learners and coaches are now being utilised. This facilitates emotional learning effects, which are especially important in education and social sector occupations.

Visualisation of scientific correlation
Immersive media are outstandingly well suited to affording learners deeper insights into phenomena of nature and technology. Sequences and types of effect can be illustrated in detail, at any speed and from any perspective desired. AR and VR can incite an enthusiasm for technology and for the sciences amongst more young people.

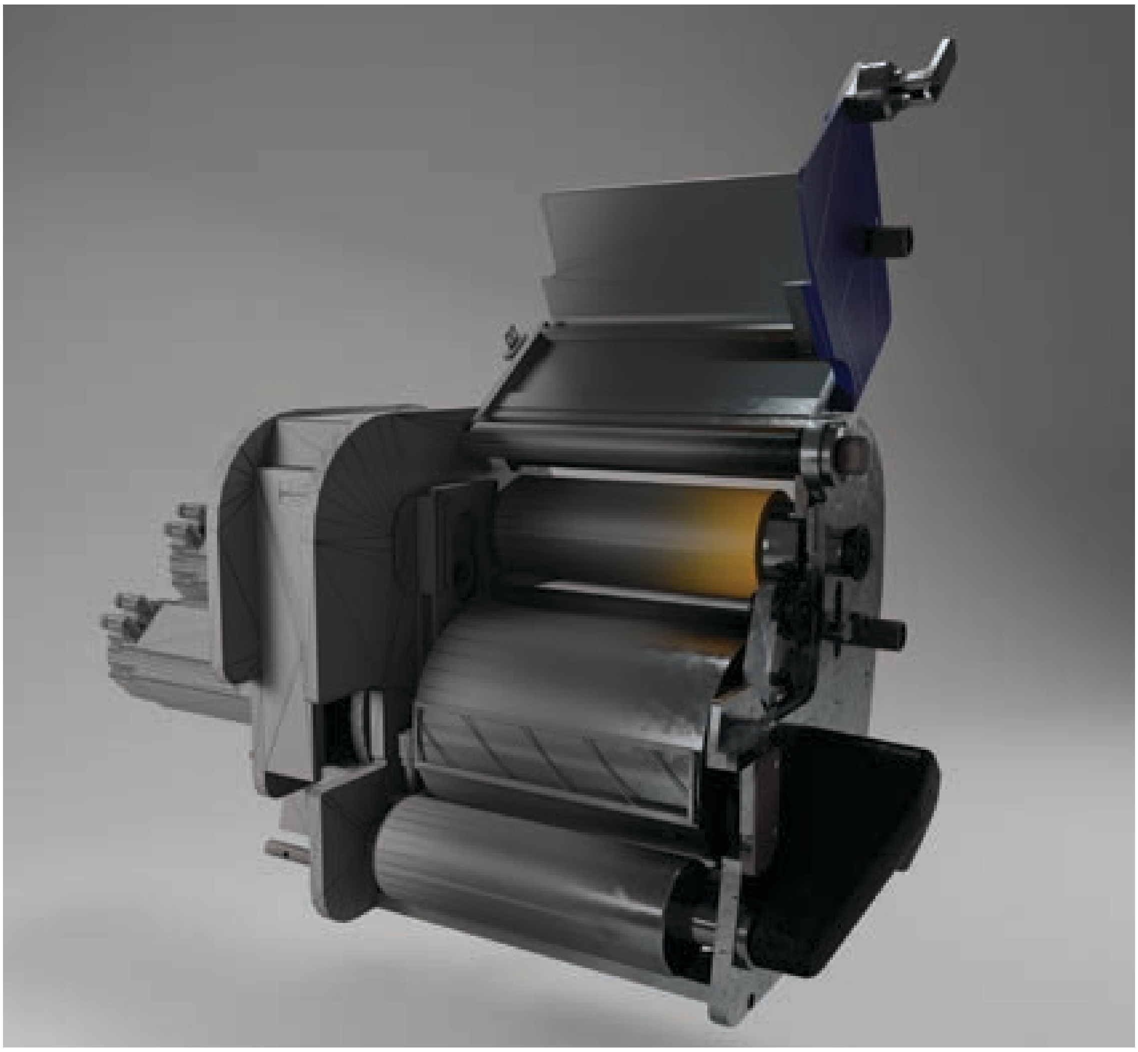
Now that we have presented various areas in which the use of immersive learning media is appropriate, the following section will set out the specific steps for the planning of AR/VR learning projects.

2 Planning the use of AR/VR in vocational education and training

This section begins by describing the fundamental technical and organisational prerequisites for the use of AR/VR (**cf. Chapter 2.1**). This is followed by a description of learning objectives for this type of project (**cf. Chapter 2.2**). Finally, the most important content-related, technical and organisational issues are presented in the form of a check list (**cf. Chapter 2.3**). Responding to the questions in the check list will help you to scrutinise the feasibility of use of AR/VR in your own VET context and thus provide you with a well-founded decision-making basis for the implementation of AR/VR learning scenarios.

The aim of describing typical Learning Scenarios (use cases) in **Chapter 3** is to offer you specific starting points and ideas for the content-related, technical and organisational planning and organisation of AR/VR learning scenarios in VET.

Visualisation of 3D content creation from vertices and edges to textured meshes (left to right)



Source: Christian Dominic Fehling / Project Social Virtual Learning

2.1 Technical and organisational prerequisites

The use of Immersive Media currently underlies highly diverse conditions. Such use ranges from simple cardboard solutions for smart phones all the way to sophisticated VR studios which boast additional technical components such as tracking solutions via bodysuits to movement control via 360° belts. For this reason, it is not easy to describe general prerequisites. The most important categories are set out below.

3D-Models

Interactively usable 3D-Models of learning objects or environments (e.g. of machines and the workplace) are required for the development of virtual computer-generated learning environments. These digital twins of the real world make virtual learning possible in the first place. The availability of authentic, realistic and pre-prepared 3D models therefore constitutes the greatest technical hurdle to the creation of AR/VR learning contents. There are various possible solutions in this regard.

- The semi-automated processing of CAD-Data from machine and plant development.
- The modelling of new 3D content on the computer, as it is common for development of computer games.
- The capturing of physical objects and environments using imaging techniques such as Photogrammetry.

However, in light of the growing role of 3D in many areas, e.g. Mixed Reality (MR), 3D-Printing, Building Information Modelling (BIM) and Computer-aided Design (CAD), it will become increasingly easy in the future to obtain ready-made models. Content authors, new services and manufacturer-based derivation of product development data will all be of assistance in this respect.

There is already a growing demand for skilled workers in this area, which cannot be adequately covered at present. For this reason, and as a result of an initiative undertaken by the Federal Institute for Vocational Education and Training (BIBB), a new training occupation entitled *"designer of immersive media"* will be created in Germany.

Suitable selection of hardware

Selection of hardware is one of the most difficult decisions in the implementation of AR/VR projects.

- In general, it is necessary to arrive at a compromise between the investment costs associated with the acquisition of a Head-Mounted-Display (HMD) and the benefits of using immersive technologies for learning purposes to ensure an adequate relationship between costs and benefits. For educational institutions it is, for example, scarcely possible to finance the acquisition of high-end VR goggles for all students.
- Against this background, it is necessary to weigh up which hardware is really needed to achieve the learning objectives. For example, it is not necessary to purchase the latest and most expensive equipment for the visualisation of simplified process flows. Likewise, it should be determined if a 360-degree video could be adequate for presentation of the contents, or if there is rather a need for the direct interaction and spatial experience afforded by a computer-generated learning environment?

Suitable rooms, space requirements and safety

Depending on the technology being deployed, it is essential to consider the space required to construct or set up the AR/VR system.

- Especially for the use of **Room-scale** VR, for example, to enable the use of machines in original size or to ensure free navigation of users, it should be ensured that space is not too tight. If the right room size is not permanently available, then mobile solutions can be relied upon. These can be installed in training rooms as needed.
- Some **PC-based VR** systems still make use of tracking methods that require the setup of additional (camera- or laser-based) tracking components in the room.
- **Standalone VR** headsets, which can be used by themselves without a separate computer, become more widespread. This equipment is easier to use spontaneously in a teaching situation. As goggle users are shut off visually, it is essential that due consideration is given to accident prevention measures (open area with no obstacles, no risk of collisions with other participants).

2.2 Learning objectives and didactic methods

Every project for the creation of digital learning media (i.e. not solely for the use of AR/VR technologies) should commence with the clarification of learning objectives. This step is vitally important for the following reasons:

- A realistic expectation of the results of the project can be established.
- It is necessary to ensure that the learning objectives and forms of learning or didactic methods deployed *"match up"*.
- The expected added value of a project is rendered transparent.

Soft skills, for instance, cannot be developed in a sustainable way without supportive, extensive and detailed feedback on the learning activity. The learning effect would remain superficial, and long-term competence development would not ensue.

The definition of learning objectives is especially important when preparing AR/VR learning projects because of the comparatively high costs of production.

For this reason, this chapter presents a brief introduction to the development of learning objectives and didactic methods.

STEP 1 Defining cognitive and affective learning objectives

Bloom's Taxonomy* provides a route towards characterising the learning objective. Bloom's goals of 1956 form six main stages, which differ in respect of complexity of the objectives or tasks. The order of these cognitive learning goals also portrays a hierarchy. If a person is able to understand something, for example, he or she will also be able to remember the learning contents. Those who create something will also be able to understand the object of learning.

Usually, however, the Bloom stages are insufficient in order to differentiate learning objectives in detail. Affective Learning Objectives are often of interest, especially when immersive technologies are being used. In addition to this, the stages for some descriptions of learning goals are not sufficiently differentiated.

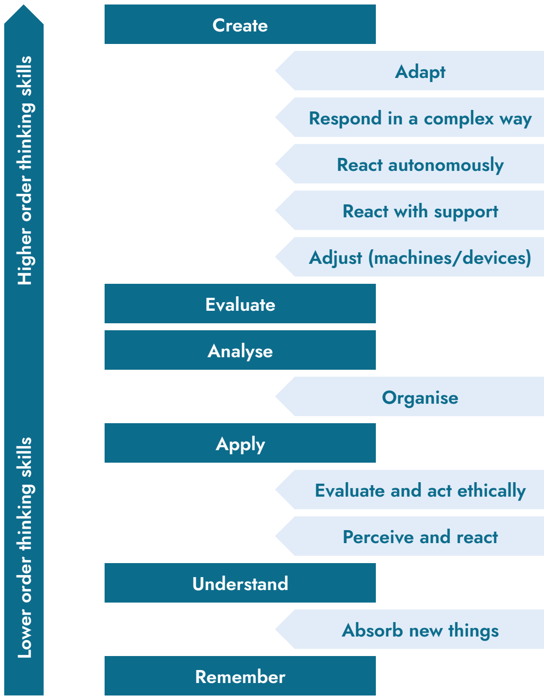
As a result, these taxonomy levels have been supplemented in many respects. We propose the following extensions for AR/VR learning applications as shown in the figure to the right.

This expansion does not represent a clear hierarchy because a multitude of different aspects is connected with the respective objectives. Whereas *"organise"* and *"adjust"* are associated with the practical tasks of an occupation or job, the goal of *"acting ethically"* can only be achieved by making changes to behaviour or to life attitudes. The former may be imparted via practically related training, whereas behavioural changes are frequently only attainable through learning experiences which activate the emotions. Immersive Media offer new opportunities in the latter area in particular.

STEP 2 Setting the learning context

In order to define learning objectives precisely, the target group and the learning venue should, of course, be described too. Older people in particular need to be introduced to new learning technologies carefully, since they have not usually become familiar with these during their learning biography. In this case, the use of AR/VR presents a particular challenge with regard to the relationship between learners and trainers and teachers. The latter should study the new forms of learning extensively and undergo supported induction before they use them in their training and teaching. This will enable the benefits of immersive technologies to be communicated and made tangible. At the same time, efficient implementation by competent teaching staff will be ensured.

Left: Revised Taxonomy after Bloom
Right: Proposed extensions for AR/VR learning



* Source: Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H. & Krathwohl, D. R. (Eds.) (1956). Taxonomy of Educational Objectives. The Classification of Educational Goals, Handbook I: Cognitive Domain. New York: David McKay Company
For more information: https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

Source: Christian Dominic Fehling

STEP 3 Selecting suitable didactic methods

The next step involves selecting didactic methods to be applied in accordance with the learning objectives. Whereas didactics addresses what (contents) should be learned and why learning should take place (goals), methodology is concerned with the question of how – i.e. which methods are to be adopted and in which form this should be achieved. Some methods that have the potential to be applied in the area of AR/VR-based learning are as follows.

- **Drill and practice**
  Exercises are repeated during training until the learner masters it with ease, e.g. certain hand movements with machines or equipment.

- **Demonstrate – imitate**
  Trainers demonstrate the execution of certain professional activities and explain their approach. Learners observe and ask questions and finally carry out the activity themselves.

- **Task-related learning**
  Learners acquire new knowledge by completing tasks and exercises. Usually, they only receive feedback after completing the exercise phase. Digital technologies allow teaching staff to provide immediate feedback, e.g. during interactive exercises.

- **Teaching the scientific method**
  The starting point of this teaching method is the presentation of a *"problem"*, e.g. in the shape of scientific phenomenon or technical functions. The task of the learners consists of defining this problem, and, based on their prior knowledge, autonomously developing concepts for its solution or explanation (formation of a hypothesis), testing this hypothesis and evaluating the results.

- **Circuit learning**
  A way of organising teaching, in which learners usually work in a self-directed and hands-on way using pre-prepared materials or media which are arranged at different stations in the teaching room or within the teaching environment.

- **Project/project-based learning**
  Project-based learning involves teaching and learning on the basis of practical assignments which relate to future occupational practice. Learners receive or assign themselves a task, which they work on as a team. The task consists of a technical problem, for which they develop a possible solution themselves. They receive advice, but largely work independently within a limited time period.

- **Learning by teaching**
  Learning by teaching encourages students to take on the role of the teaching staff in order to enhance their own understanding of the subject of learning. This may involve that students take on lectures or presentations themselves or create new learning materials, e.g. learning videos.

- **Open teaching**
  Open teaching is a form of teaching which allows all learners to freely determine the time, venue and content of learning. Learners can also choose whether learning contents are processed alone or via group work and are also able to select the methods to be used.

- **Free work**
  Free work grants learners a great deal of autonomy and personal freedom. It constitutes an expanded form of open teaching (see above), in which learners set a learning objective themselves. They then attempt to achieve this goal via their own efforts.

- **Learning on demand (e.g. during daily work / in-company training).**
  Learning takes place in the work process when it seems necessary or useful. Learners can access relevant learning and training materials as needed to get direct support with a problem or operational question.

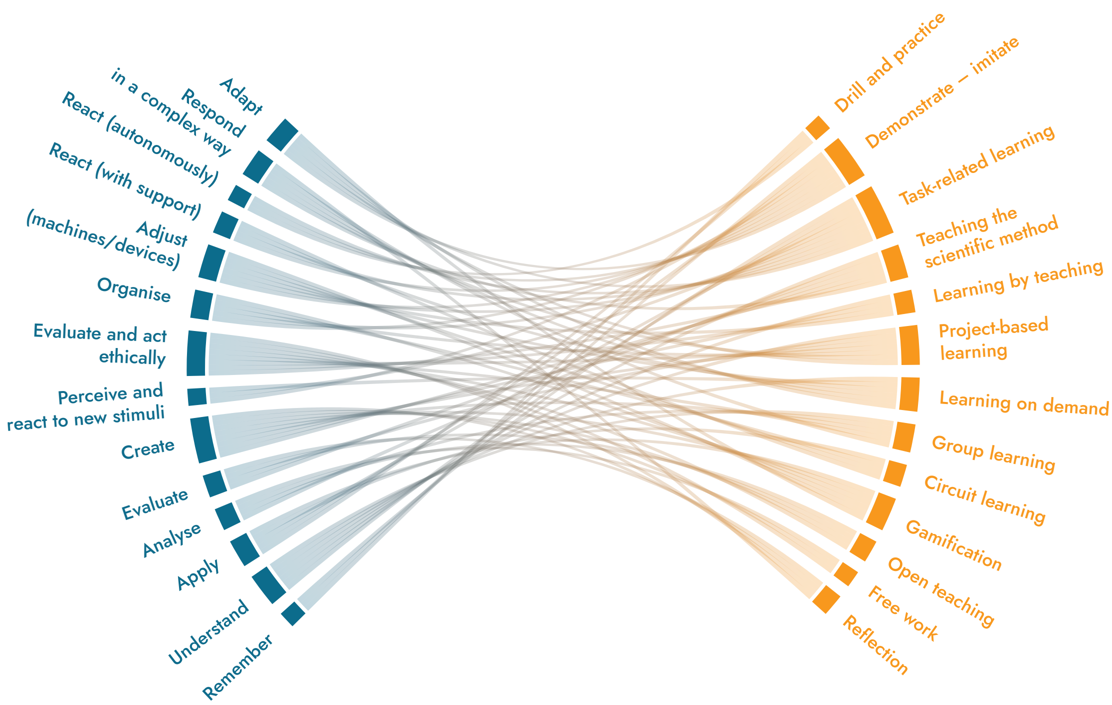
- **Reflection**
  Learners reflect on their own learning process (e.g. in the context of a learning project) by documenting their learning status and/or describing problems that have arisen. The results are discussed with the teaching staff in order to jointly determine the next steps.

- **Group Learning / Cooperative Learning**
  Groups of learners independently acquire new knowledge in order to complete a given task. For this purpose, learners work together and receive feedback from their fellow learners to achieve a learning goal.

- **Gamification**
  The combination of immersive learning media and game-based learning offers particular potential because the emotional involvement and motivation of learners receive an additional boost. This is especially true of younger target groups.

The combination of specific didactic methods and learning objectives is not predetermined. There is a multitude of possible variants and main focuses. Nevertheless, the findings that have emerged from educational research* and experiences gained from learning projects permit a loose allocation to be made.

Selecting suitable didactic methods to achieve the learning objectives



* Martin Ebner and Mandy Schiefner: Looking Toward the Future of Technology-Enhanced Education: Ubiquitous Learning and the Digital Native, 2010

Source: Christian Dominic Fehling

All didactic methods listed below may be used in connection with **Immersive Media**. Examples can be found in the 11 didactic scenarios which we describe in **Chapter 3**.

List of learning objectives and applicable didactic methods

Learning objectives	Didactic methods
Remember	Drill and practice Demonstrate – imitate Task-related learning
Understand	Task-related learning Teaching the scientific method Learning by teaching Project-based learning Learning on demand Group learning
Apply	Drill and practice Demonstrate – imitate Task-related learning Circuit learning Gamification
Analyse	Teaching the scientific method Open teaching Free work Group learning
Evaluate	Teaching the scientific method Open teaching Project-based learning Reflection
Create/create new things	Teaching the scientific method Open teaching Learning by teaching Free work Project-based learning Gamification Reflection Group learning
Perceive and react to new stimuli	Demonstrate – imitate Task-related learning Learning on demand

List of learning objectives and applicable didactic methods

Learning objectives	Didactic methods
Evaluate things ethically and act ethically	Teaching the scientific method Open teaching Learning by teaching Free work Project-based learning Gamification Reflection Group learning
Organise	Demonstrate – imitate Task-related learning Project-based learning Circuit learning Gamification
Adjust (machines/devices)	Demonstrate – imitate Task-related learning Learning by teaching Circuit learning Gamification Learning on demand
React with support	Demonstrate – imitate Task-related learning Circuit learning Learning on demand
React autonomously	Drill and practice Demonstrate – imitate Task-related learning
Respond in a complex way	Teaching the scientific method Open teaching Free work Project-based learning Learning on demand Reflection Group learning
Adapt	Demonstrate – imitate Task-related learning Gamification Project-based learning Learning on demand

2.3 Checklist for the use of AR/VR in vocational education and training

The following check list will help you to take account of important questions when planning and preparing an **AR/VR** project. All project participants and external service providers should be integrated into the decision-making process.

Contents/didactic approach

- [ ] Is the choice of AR/VR useful and effective in terms of imparting the learning contents and achieving the specified learning objectives? What added pedagogical value does the use of immersive technologies offer? Which obstacles exist regarding the transfer of knowledge or acquisition of competencies that need to be overcome by using AR/VR? Are there better or more cost-effective options?
- [ ] What are the learning objectives to be achieved with the use of AR/VR? Is the main aim for learners to acquire occupational competencies or soft skills that require the training of certain (inter)actions in the virtual environment, or is the principal focus on factual knowledge?
- [ ] Is the idea for learning to occur predominantly alone, or should it take place collectively, e.g. during **Classroom-based Teaching / Learning**?
- [ ] Are the learners well acquainted with technology, or do they need more time or support to familiarise themselves?
- [ ] Is AR or VR a better fit for the respective learning objectives, target group, depiction of contents or for the type of deployment? Should, for example, the real environment remain visible whilst learning is taking place, that requires the choice of an AR solution?
- [ ] Which degree of **Immersion** is necessary in order to achieve the learning objective? Should the learners feel emotionally addressed by the virtual world of learning? Do I need an **Avatar** resembling a human to support interaction with the virtual protagonists and to assist with **Emotional Activation** of the learners?
- [ ] Is the available technology effective enough to achieve the learning objective via an AR/VR-aided form of learning? Do I require additional means and methods (e.g. to monitor learning progress)? Or is it necessary to choose alternative forms of learning or to combine them with AR/VR-aided learning to achieve the learning objective (e.g. practical training using a real machine)?

Technical approach

- [ ] Which hardware can be used to depict the learning contents adequately? Is state-of-the-art technology required, or will more cost-effective solutions suffice?
- [ ] Can the hardware be used in a risk-free and useful way at the learning venue, e.g. if noise or dirt is produced?
- [ ] Is a mobile solution needed (e.g. tablet or **Standalone VR** headset), or can the application be permanently installed in a training room?
- [ ] Which interactive devices are required for the respective teaching/learning scenario (e.g. **Controllers**)? Can the application be controlled via hand gestures? Is language recognition useful in order to be able to control the programme via voice commands?
- [ ] Which senses should be addressed? Is an audio output needed, for example?
- [ ] Does the project have access to and usage rights for **3D-Models** or can such rights be obtained?
- [ ] Which software can be used to implement the contents, and who can provide support?
- [ ] Are the learning contents essentially static / in need of little change or will I need an authoring tool in order to be able to adjust contents myself?

Organisational and legal approach

- [ ] Do the education and training establishments have a sufficiently large space available for use of the desired solution?
- [ ] How many devices must be procured in order for the learning scenario to be effective in school classes too? Will it be sufficient to use a single VR headset for individual learning, or is the intention to learn collectively within the virtual environment in order to facilitate communication?
- [ ] Is it possible to comply will all regulations relating to accident prevention?
- [ ] Which provisions are in place regarding hygiene measures when using the goggles and devices (during and after the pandemic)?
- [ ] What could be a fall-back solution for learners who suffer from **Motion Sickness** and cannot use VR despite the high-quality technology being deployed?
- [ ] Are additional fee-based licences necessary, e.g. because extra programmes or technical components are being used? Might this potentially restrict the use or dissemination of AR/VR contents?
- [ ] Which data do AR/VR devices collect and store, e.g. about users' body motions and the environment? Who can access these data and how? Which data protection rules apply?

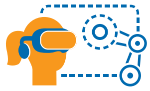
3 Identifying appropriate learning scenarios

Let us begin by checking that you are able to find a suitable Learning Scenario by using this guide. Take a look at the 11 headings shown to the right. They correspond to *"clusters"* which we have formed from researching and analyzing a multitude of AR/VR learning projects.

Have you found a suitable learning scenario? On the following pages you can find how these learning scenarios are described, which target groups they are appropriate for, which didactic concepts are applied (**cf. Chapter 2.2**) and which technical constellation is most suited for a practical application (**cf. Chapter 2.1**). The example projects offer a plastic representation of how the respective learning scenario may specifically look.

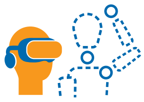
The description in each scenario is intended to provide you with ideas on how to plan and design your own AR/VR-based learning application.

If you are not precisely sure of what the individual specialist terms used in the scenario descriptions mean, check the definitions and explanations in the **Glossary of terms**.

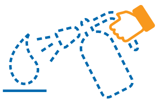


3.1 **Interaction with machines**
Gaining a better understanding of complex devices

3.2 **Motor skills training**
Practising certain movement sequences



3.3 **Working with avatars**
Simulations which use virtual human mannequins



3.4 **Dealing with unfamiliar situations**
Behavioural training to prepare for emergencies

3.5 **Safety/accident prevention**
Training for the prevention of risks and to learn about safety measures

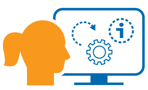
3.6 **Acquisition of professional competencies**
Employment-oriented training for different specialist areas

3.7 **Understanding nature and physics**
Explanation of scientific facts

3.8 **Acquisition of social competencies**
Training aimed at improving communication and interaction skills

3.9 **Assistance systems**
Use of systems which provide support in the performance of various actions

3.10 **Acting ethically**
Training which helps people to reflect on the consequences of their own actions



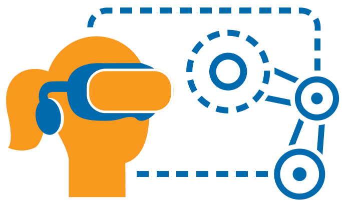
3.11 **Using authoring tools**
Making use of design environments for the creation of AR/VR learning scenarios

3.1 Interaction with machines
Gaining a better understanding of complex devices

The purpose of projects in this Learning Scenario is to familiarise learners with the way in which machines and plants work. The aim is that they will be able to operate such machines and, if necessary, also to maintain and repair them. Representation in a 3D environment is chosen as approach to show details which are not easily visible in reality. In addition, the use of machines in an immersive environment will become an emotional experience.

Which technical constellations are deployed?
Almost all technical constellations are possible options for learning about and experiencing machines. However, Virtual Reality (VR) is currently used much more frequently than Augmented Reality (AR), using a computer-generated Digital Twin instead of augmenting real machines. Input devices that offer six Degrees of Freedom (DoF) are most suitable for creative operation and exploration of these machines, as they allow users to naturally manipulate virtual objects.

Which target groups are addressed?
The scenario is essentially suitable for all target groups, although it is particularly useful for trainees and young adults/career entrants. The learning applications can be used to facilitate both self-directed learning by individuals and group-based learning.



Which learning objectives are pursued?
Which didactic concepts are applied?

- Understand
- Evaluate
- Teaching the scientific approach
- Demonstrate – imitate
- Task-related learning
- Gamification

Example project for this learning scenario

Title: Social Virtual Learning (SVL)

Information: The project Social Virtual Learning (SVL) was implemented from September 2016 to August 2017. It created a Virtual Reality (VR) learning environment for the operation of printing machines.

This virtual learning environment enables learners to use a virtual printing machine to experience work processes in a direct and interactive way. A high degree of Immersion allows real life experiences to be gained via the virtual object. Learners also find more fun in discovering complex machines, and this is a significant factor too. Irrespective of the availability of real machines at the learning venue, SVL thus helps practical and workplace-related learning experiences to be gathered during initial and continuing VET. The main focus is on employment-oriented learning. Relevant exercises assist with the development of employability skills and procedural knowledge.

Source: Julian Gaab, composing by Christian Dominic Fehling / Project Social Virtual Learning

3.2 Motor skills training

Practising certain movement sequences

Virtual Reality (VR) learning also allows occupationally related movement sequences to be rehearsed in a risk-free space. In this sense, it works in a similar way to game applications which enable users to perfect their golf swing or practise a tennis backhand. The key elements of this Motor Skills training are precision and routine. Examples would be spraying a car bonnet or welding. Achieving the right speed of movement and maintaining the correct distance from the work piece are crucial in both of these cases. Such *"dry runs"* also do not waste any materials.

Assistance Systems, which report in real time whenever a movement has not been executed correctly, offer a further benefit as compared to live practice in the actual world. Self-directed learning can take place without any need for corrective interventions by a trainer.

Which technical constellations are deployed?
VR systems which allow and can record movements within the space, e.g. via Controller and appropriate Tracking systems (such as Inside-out), are useful options here. Depending on the level of technical development, consideration may also be given to systems which are capable of identifying the position of the fingers or other bodily postures. Tactile Input systems which are able to deliver Haptic Feedback would also be suitable for motor skills training if such systems undergo further development in future.

Which target groups are addressed?
The full spectrum of target groups can be addressed. These range from trainees to young skilled workers already employed in the occupation and also extend to include *"old hands"*. Beginner, advanced and expert levels can all be covered.

Which learning objectives are pursued? Which didactic concepts are applied?

- Understand
- Apply
- Analyse
- Demonstrate – imitate
- Gamification
- Drill and practice

Example project for this learning scenario

Title: MESA – Use of Media in Welding Training

Information: The project MESA seeks to encourage the use of digital media in VET in the metal working occupations. Welding **Simulations** are a specific innovation within the sector which offer significant benefits in the learning process. A systematic didactic and pedagogical approach is necessary in order to facilitate their effective deployment. Such an approach has been developed within the scope of the German funding project MESA. The aim of the project is to integrate digital media into a needs-oriented training concept with a strong didactic basis. MESA is supporting the general contents of both inter-company training and company-based training in welding.

Source: Project MESA

3.3 Working with avatars
Simulations which use virtual human mannequins

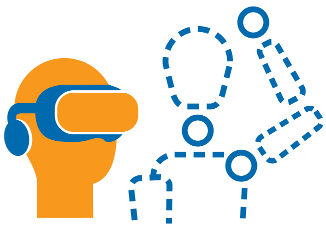
This AR/VR Learning Scenario is by all means closely connected to motor skills training (**cf. Chapter 3.2**). The focus is on haptic or tactile contact with other people, e.g. in diagnostic or emergency situations. For this reason, projects in this group frequently address nursing or medical tasks.

Nursing care and emergency medicine are two areas in which there is plenty of scope for career entrants to make mistakes. Training on real people is therefore risky. Certain cases, such as anaphylactic shock following a wasp sting, occur only rarely. Nevertheless, all treatment steps need to be performed rapidly and correctly, and any errors may have serious consequences. Body models or mannequins are thus widely used for demonstration purposes during face-to-face training. Such a Training Dummy is a particularly familiar feature in the teaching of cardiopulmonary resuscitation. Such dummies can also measure whether treatment is being carried out properly.

In Virtual Reality (VR), comparable training dummies are represented both digitally and three dimensionally. They can, for example, be used in midwife training or for practising colonoscopies. These systems are able to supply feedback on the correctness of treatment.

Which technical constellations are deployed?
As is the case with Motor Skills training, virtual reality systems are also useful here if they are able to record movements within the real space via appropriate input methods (Controllers) and tracking systems (e.g. Inside-out) and then reflect these in VR. Systems with extended Tracking functionalities (which are, for example, capable of recognising individual fingers or entire bodily postures) and Tactile Input systems (able to deliver features including Haptic Feedback) will also be of relevance in the future.

Which target groups are addressed?
Learning applications can be suitable for both beginners and advanced learners. The main target groups using this learning scenario are trainees and career entrants as well as experienced employees.



Which learning objectives are pursued?
Which didactic concepts are applied?

- Apply
- Understand
- Task-related learning
- Demonstrate - imitate
- Drill and practice
- Gamification

Example project for this learning scenario

Title: EPICSAVE – Enhanced Paramedic Vocational Training with Serious Games and Virtual Environments

Information: The German funding project EPICSAVE uses a **Serious Game** – based on virtual reality and presented in the form of a **Simulation** – to prepare trainee paramedics for emergency situations which would otherwise be extremely difficult to practise. Life-threatening allergic shocks suffered by children are one particular example in this regard.

Source: Project EPICSAVE

3.4 Dealing with unfamiliar situations
Behavioural training to prepare for emergencies

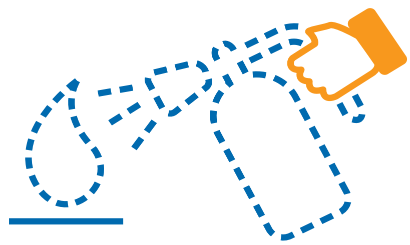
Some situations need to be practised in the hope that they will never occur. Hospital nurses, for example, hope that they will not be called upon to extinguish a ward fire. *"Analogue learning"* offers first aid courses or fire safety drills for these sorts of areas of training. These can also be transferred to **Virtual Reality (VR)** or **Augmented Reality (AR)**. The aim here is for the training to allow trainees to fully absorb and internalise certain sequences in order to be able to instigate the right measures should an unfamiliar situation occur.

The advantage of such a **Simulation** is that emergencies can be practised without harming anyone or anything.

Which technical constellations are deployed?

As was the case with **Motor Skills** training (**cf. Chapter 3.2**) and working with **Avatars** (**cf. Chapter 3.3**), technical constellations are useful if they permit as many **Degrees of Freedom (DoF)** as possible, i.e. a larger range of movement, and if actions can be directly steered using **Controllers** or other devices. This is another area in which further technological developments, e.g. within the field of **Haptic Feedback**, will gain in relevance in the future. Otherwise, the more **immersive** the learning situation (e.g. because of the deployment of **Head-Mounted-Display (HMD)**, a realistic VR environment and credibly designed avatars), then the more emotional and the more in-depth the learning experience will be.

Which target groups are addressed?
Experienced staff are slightly more likely to be addressed, but the target groups also include young adults who are able to practise unfamiliar situations at both *"beginners"* and *"advanced"* level.



Which learning objectives are pursued? Which didactic concepts are applied?

- Understand
- Apply
- Analyse
- Perceive and react to new stimuli
- Free work
- Gamification

Example project for this learning scenario

Title: TRACY – Game-based Training for Disaster and Emergency Scenarios

Information: The German funding project TRACY uses Game-based Learning (GBL) in the area of internal disaster prevention in hospitals in order to provide advanced and continuing training to medical, nursing and technical staff. A **Serious Game** simulating various internal catastrophe scenarios was developed on the basis of a university hospital's disaster plan and used to provide participants with directly relatable experiences.

Source: Project Tracy:VR

3.5 Safety/accident prevention
Training for the prevention of risks and to learn about safety measures

This AR/VR Learning Scenario is closely related to *"Dealing with unfamiliar situations"* (**cf. Chapter 3.4**) and *"Interaction with special machines"* (**cf. Chapter 3.1**). However, in the case of safety and accident prevention training preparatory measures form the object of the learning situations. Learning thus centres on rules and specific steps for the targeted avoidance of emergencies. Well-known examples of such training in the *"analogue learning world"* include road safety and courses on how to load freight properly and securely.

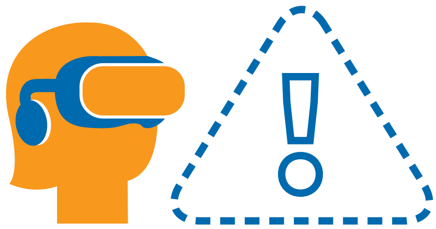
Using a VR learning scenario offers the opportunity to bring tedious material alive, including during such **Classroom-based Teaching / Learning** sessions. The rules for stacking pallets of goods in a warehouse can be learned off by heart. But learners gain an emotional experience if they themselves work within a VR space to pile up the pallets in accordance with these rules. They can also experience the tipping over or collapse of the pile. This **Labilization / Sensitization** assists in obtaining a better understanding of the purpose of certain rules. Topics may also involve something as simple as avoiding scratches to paintwork during automobile manufacture.

Which technical constellations are deployed

This scenario is used to simulate technical plants such as production lines and wind turbines and enables relevant prevention and safety measures to be practised. Replicating devices of this kind in a computer-generated space is time consuming and expensive, although conversion of existing **CAD-Data** may speed up the process. This learning scenario also benefits from multiple **Degrees of Freedom (DoF)**. In addition, a **Digital Twin** must offer extensive settings to replicate realistic fault or emergency scenarios.

Which target groups are addressed?

The learning scenario is principally suitable for beginners in these thematic areas, i.e. the main target groups are young people in training and young adults/career entrants. Experienced staff, however, can be also addressed. There is no doubt that the VR environment helps raise participants' motivation, even though the material subsequently becomes somewhat *"dry"*.



Which learning objectives are pursued? Which didactic concepts are applied?

- Understand
- Apply
- Demonstrate - imitate
- Task-related learning
- Gamification

Example project for this learning scenario

Title: MARLA - Masters of Malfunction: A Game-Based Mixed Reality Learning Application with Digital Language Assistance for Training in the Area of Wind Energy Technology

Information: This German funding project used a VR Game-based Learning (GBL) learning application to practise error diagnosis competence in electrical engineering and metal technology during VET. Wind energy technology was the particular example used.

The overall objective of the project is to use Mixed Reality (MR) technologies, digital voice Assistance Systems and Serious Game to develop a modern and risk-free learning application for use in wind energy technology training in Germany in the occupational fields of electrical engineering and metal technology

Source: the Good Evil / Project MARLA

3.6 Acquisition of professional competencies
Employment-oriented training for different specialist areas

This cluster or **Learning Scenario** encompasses all projects and applications which impart occupation-specific competencies. Some can be allocated to several occupational groups (e.g. an application for spatial vision), whilst others are geared towards trainee cooks or staff in the print industry, for example. Over recent years, targeted funding from the German Ministry of Education and Research (BMBF) has also led to the development of many projects aimed at people with disabilities. This cluster contains many such professionally specific projects relating to certain fields of application.

Any mention of **Professional Competencies** refers not merely to specialist knowledge but also to the application of this specialist knowledge in certain situations (including the unfamiliar). In other words, the focus is on **Employability Skills**.

Thus all described learning objectives and didactic concepts (**cf. Chapter 2.2**) are possible options. The character of the respective professional competencies needs to be stipulated in greater detail for the learning objective to be defined. The relevant training regulations or professional competence standards may offer starting points in this regard.

Which technical constellations are deployed

The potential range of the applications collated within this cluster means that no generally valid recommendations can be provided in respect of the technical constellations. Nevertheless, initial points of reference may be gleaned from the other learning scenarios depicted in the present publication and from their respective learning objectives.

Which target groups are addressed?

Employment-oriented learning measures using **AR/VR** are conceivable for all target groups in principle, but they are mainly suited to young people/trainees and to young adults at beginner level. In addition to this, people with disabilities can be particularly effectively targeted.

Which learning objectives are pursued?
Which didactic concepts are applied?

AR/VR-based applications may also focus on the following learning objectives, especially if the aim is the inclusion of people with disabilities. The pursued objectives and applied didactic concepts thus deviate from the ones generally used in this publication.

- Participation in VET
- Imparting of basic principles
- Adapting learning contents to certain disabilities

Example project for this learning scenario

Title: [InProD² - Inclusion in Production]

Information: The transformation to **Industry 4.0** is creating challenges for numerous occupational fields and therefore also for VET as a whole. These challenges must not be underestimated. This transformation is not only driven by technological development, but is also accompanied by social changes, for example in the way in which we deal with digital media.

Digital media can help people to tap into their own individual education and training potential. However, existing initial and continuing VET provision – developed within the scope of a move towards *"VET 4.0"* – is frequently not aligned towards the needs of people with disabilities. The German funding project InProD² brings together existing training solutions in the professional practitioner* occupations of bookbinder, media technologist in print processing and print media technologist and reappraises these solutions in a (partially) automated and needs-oriented manner and subsequently makes them available to trainees via an intuitively operable interface.

* Professional practitioner is a recognised vocational qualification in Germany aimed at young people who are unable to complete regular training because of a disability. Professional practitioner training enables companies to offer a structured training programme in accordance with standardised criteria and thus opens up long-term employment prospects for persons with a disability.

Source: Christina Hanck, composing by Josephine Schipke / Project MARLA

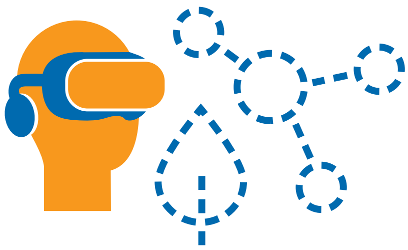
3.7 Understanding nature and physics
Explanation of scientific facts

Although this AR/VR Learning Scenario also focuses on specialist knowledge, the focus is on conventional STEM topics, i.e. computer technology and the sciences. The aim is for the learning scenarios to adopt a game-based approach and to provide a general introduction to these topics rather than merely centering on Professional Competencies. Rote learning of formulae and definitions can put many young people off, but a great deal of potential is inherent in the individual experiencing of natural and technical phenomena via AR/VR. This may provide motivation to undergo training in STEM occupations or embark upon higher education study in the field.

Game-based scenarios are the main starting point. These emphasise the experience-based and experimental nature of the sciences.

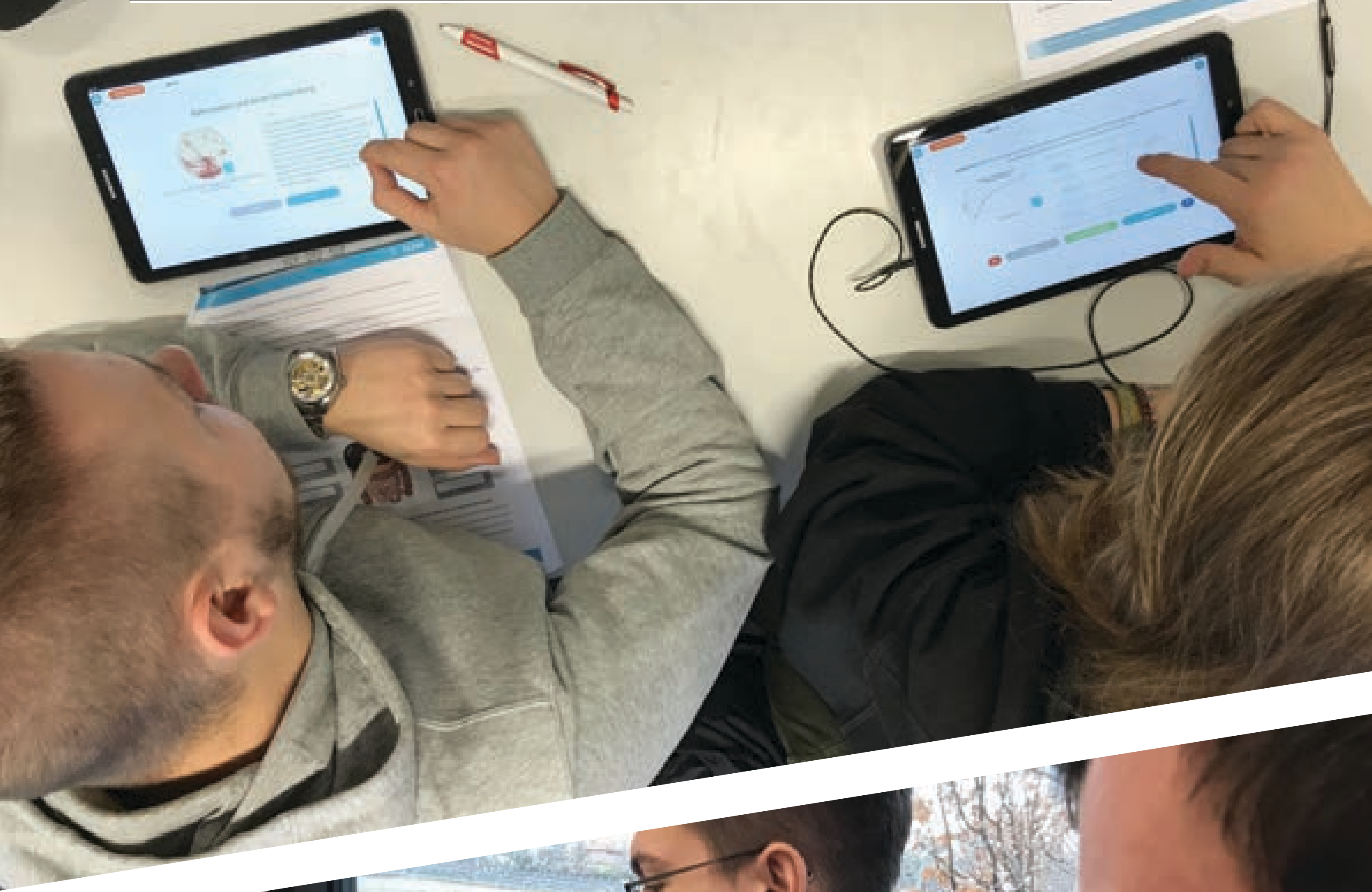
Which technical constellations are deployed
The potential range of the applications collated within this cluster means that no generally valid recommendations can be provided in respect of the technical constellations. Nevertheless, initial points of reference may be gleaned from the other deployment scenarios depicted in the present publication and from their respective learning objectives.

Which target groups are addressed?
The projects are usually aimed at trainees in Vocational Education and Training (VET) and students in higher education, but also at pupils with the objective of firing their enthusiasm for STEM professions.



Which learning objectives are pursued?
Which didactic concepts are applied?

- Gamification
- Teaching the scientific method
- Project-based learning



Example project for this learning scenario

Title: GLARS - Goal-Based Learning in an Alternate Reality Setting

Information: The project develops and pilots a multi-media learning provision for the vocational training of technical biological assistants in Germany. As part of a so-called *"alternative reality game"* (ARG), learners receive seemingly realistic research assignments which require them to solve problems. The linking of theory from teaching and practice in the laboratory is achieved via game-based elements.

Source: Project GLARS

3.8 Acquisition of social competencies
Training aimed at improving communication and interaction skills

Some people maintain that personal competencies such as **Interaction Skills**, **Communication Skills** or leadership skills cannot be taught using digital learning tools. They believe that a face-to-face approach and direct contact with a teacher are the only effective method. This may well be true if only considering more conventional learning tools like e-books or web-based trainings.

But **AR/VR** **Learning Scenarios** which are seeking to impart **Social Competencies** also focus on employment-oriented learning. Rather than learning facts off by heart, participants practise skills by interacting with other people (or avatars) in a AR or VR environment.

One advantage here is that a *"protected space"* enables inhibitions to be overcome. There is no need to fear observation from others whilst working to improve communication skills.

Which technical constellations are deployed

Several projects use **180° / 360°** videos featuring actions which learners are able to view from various angles. A learner may, for example, see a conflict between two trainees and a trainer on the shop floor and then consider what they would have done in this situation. Unlike simple training videos, 360° videos have an immersive character which makes learners feel that they are part of the action to a greater extent and that they are emotionally involved.

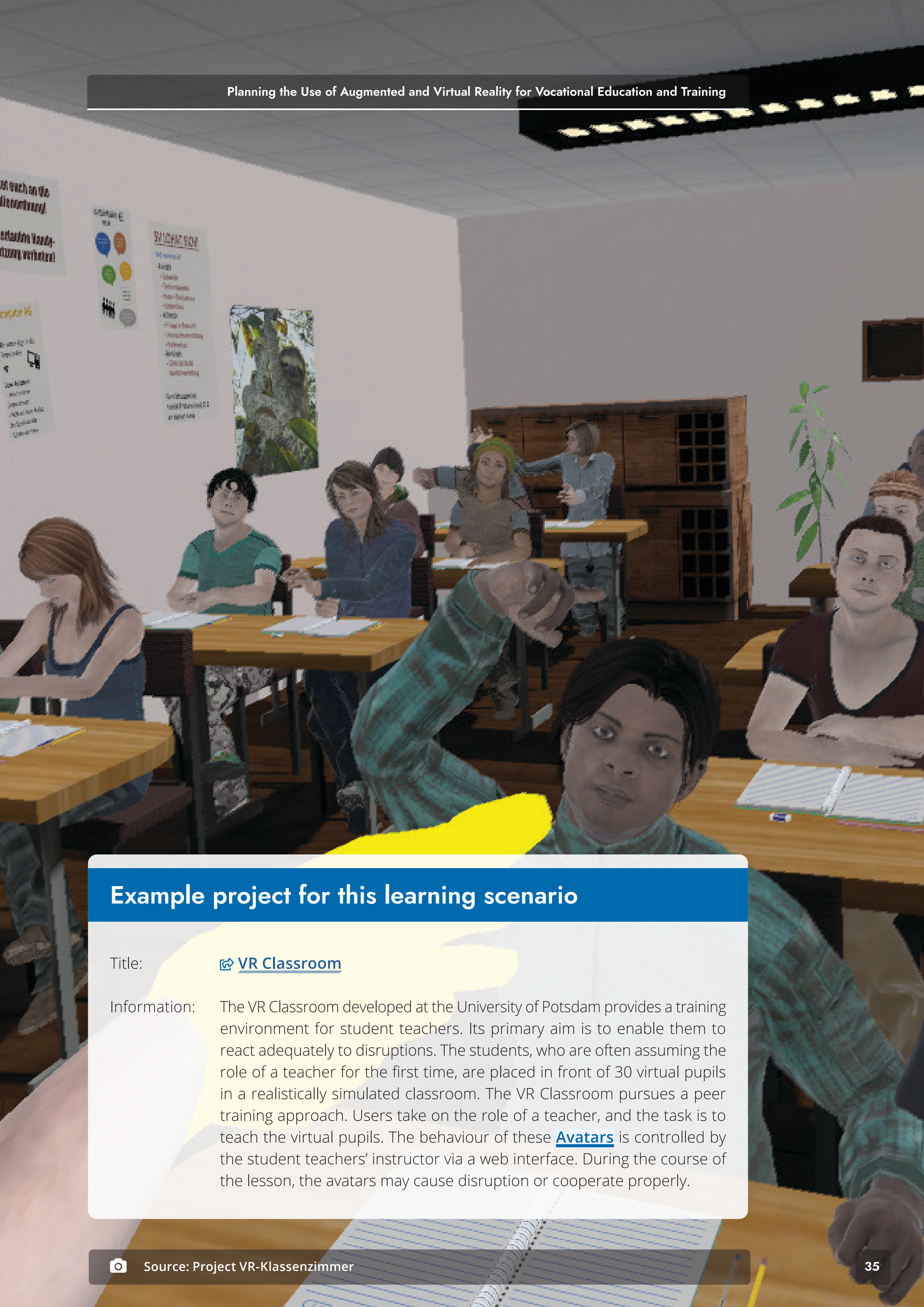
Some scenarios are structured in such a way so that learners can act from a fixed position. In other cases, it is useful to move around within the VR space. These constellations must be taken into account for selecting AR/VR equipment with the corresponding technical features, e.g. **Degrees of Freedom (DoF)**.

Which target groups are addressed?

These learning scenarios are aimed at trainees and young adults who are career entrants. They may, however, also be directed at teaching staff.

Which learning objectives are pursued? Which didactic concepts are applied?

- Understand
- Analyse
- Evaluate
- Perceive and react to new stimuli
- Evaluate things ethically



Example project for this learning scenario

Title: VR Classroom

Information: The VR Classroom developed at the University of Potsdam provides a training environment for student teachers. Its primary aim is to enable them to react adequately to disruptions. The students, who are often assuming the role of a teacher for the first time, are placed in front of 30 virtual pupils in a realistically simulated classroom. The VR Classroom pursues a peer training approach. Users take on the role of a teacher, and the task is to teach the virtual pupils. The behaviour of these Avatars is controlled by the student teachers' instructor via a web interface. During the course of the lesson, the avatars may cause disruption or cooperate properly.

Source: Project VR-Klassenzimmer

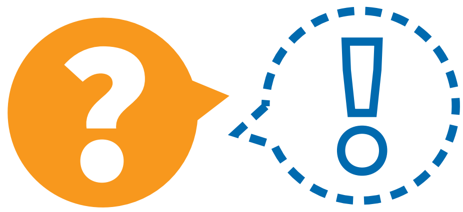
3.9 Assistance systems
Use of systems which provide support in the performance of various actions

These **Learning Scenarios** provide learners with targeted support where required. **Voice Assistance** has now become an integral part of many life situations. Obvious examples include voice-activated, all-purpose assistants such as *"Alexa"* and *"Siri"* or navigation systems in cars. The common feature of all digital assistants is that they act *"on demand"* or automatically to perform functions which people are unable to carry out for themselves for whatever reason.

This principle can also be transferred to learning processes. Digital assistants can, for example, supply short explanatory texts if something has not been understood whilst assembling components. Others may display visual information in an **Head-Mounted-Display (HMD)** or on a tablet in order to explain aspects via a real image.

Which technical constellations are deployed
The whole range of **AR/VR** systems can be used. However, careful planning needs to be undertaken in respect of the technology needed for a successful deployment (**cf. Chapter 2.3**). Assistive functions may be activated via **Controllers** or speech recognition and can for example take the form of voice assistance or interactive feedback. Planning must take account of the needs and prior learning of participants and of the respective learning situation. Voice control, for example, allows learners involved in installation to freely use their hands in VR.

Which target groups are addressed?
In general terms, **Assistance Systems** for learning are suitable for all learner groups, i.e. higher education students, trainees and young adults/career entrants. They are particularly appropriate at beginner level. Projects can also be directed in a targeted way at those with a disability. The situational needs of such persons can be individually differentiated in the learning process. This is an area in which an AR/VR-based learning system can provide disability-appropriate assistance.



Which learning objectives are pursued?
Which didactic concepts are applied?

- Understand
- Apply
- React with human or technical support
- Task-related learning
- Learning on demand
- Group learning

Example project for this learning scenario

Title: incluMOVE – Competence Acquisition and Inclusion in Vocational Education and Training via Gamification and Motor Learning

Information: The aim of the German funding project incluMOVE is to use Augmented Reality (AR) to support disabled persons involved with assembly work in such a way that enables them to acquire occupational and practical skills and support them in entering the labor market. For this purpose, a learning and workplace is created, at which people with disabilities receive specialist knowledge relating to the respective task area via digital applications. Social Competencies and methodological competence are also fostered alongside the establishment of specialist occupational knowledge. Further to this, great importance is attached to the imparting of digital competencies such as operation and use of digital learning media including tablets, procurement and evaluation of information from digital networks, and the use of assistance, Simulation, diagnosis or visualisation systems. At the same time, learning and work are enhanced via a game-based approach (Gamification) and contents gain a higher degree of relevance for users.

Source: Project Inclumove

3.10 Acting ethically
Training which helps people to reflect on the consequences of their own actions

This group of learning applications has overlaps with various **Learning Scenarios**: exercises using a virtual **Training Dummy** (**cf. Chapter 3.3**), **Motor Skills** training (**cf. Chapter 3.2**), dealing with unfamiliar situations (**cf. Chapter 3.4**) and acquisition of **Social Competencies** (**cf. Chapter 3.8**).

Alongside these learning objectives, applications can pursue a further goal in that they seek to impart ethical action principles and to encourage people to reflect upon what they are doing.

This may involve prompting action that will help others, for example as a paramedic attending emergencies. Other learning scenarios refer to actions to keep others from harm, for example by recycling mobile phones in an ecologically effective way.

Which technical constellations are deployed
This is a further area in which a wide variety of VR and AR systems may be deployed. Simple technical systems are, however, sufficient in these cases because large **Degrees of Freedom (DoF)** are not absolutely necessary. The game scenes depicted can be easily viewed whilst standing or sitting in a three-dimensional space (**3D**), and neither do users need controllers to intervene in the action. Control of the VR application via eye movements may instead be enough.

Which target groups are addressed?
These learning applications are aimed at younger target groups, i.e. young people and young adults. However, they can be also directed at teaching staff. Individual training is possible in this learning scenario, although **Collaborative Learning** in the group tends to be more effective.

Which learning objectives are pursued? Which didactic concepts are applied?

- Understand
- Act ethically
- Task-related learning
- Reflection
- Gamification

Example project for this learning scenario

Title:	SoKo VR Headset – Use of Virtual Reality Technologies to Promote Social Competence in Dual Training
Information:	As part of the German funding project "SoKo VR Headset", the Research Institute for Vocational Education and Training (f-bb) developed virtual reality learning units to foster the Social Competencies of trainees. This project makes Virtual Reality (VR) technologies usable for social learning in VET. Trainees can use VR to slip into the role of trainers and vice versa. This shift in perspective encourages mutual understanding and Empathy Learning.

Source: Project SoKo VR

3.11 Using authoring tools

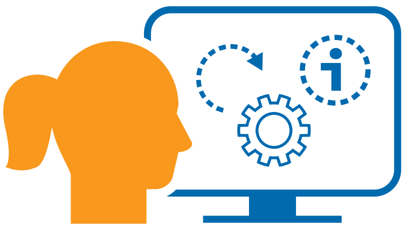
Making use of design environments for the creation of AR/VR learning scenarios

This cluster differs sharply from the first ten. The previous focus was on achievement of certain learning objectives, but the main thrust of this scenario is tools which can be used to create entirely new AR/VR contents for various application purposes. For this reason, the questions relating to learning objectives and target groups are omitted in this case.

These so-called **Authoring Tools** are, for example, capable of integrating a wide range of external objects into a virtual world – 3D objects, specialist contents, video and audio files and interactive elements (such as quizzes). They generally pursue the goal of developing a virtual **Learning Scenario** which can later be reused in other learning contexts. This means that each element does not need to be completely reprogrammed for every learning application. This represents an initial step towards standardisation of AR/VR in terms of content and structure.

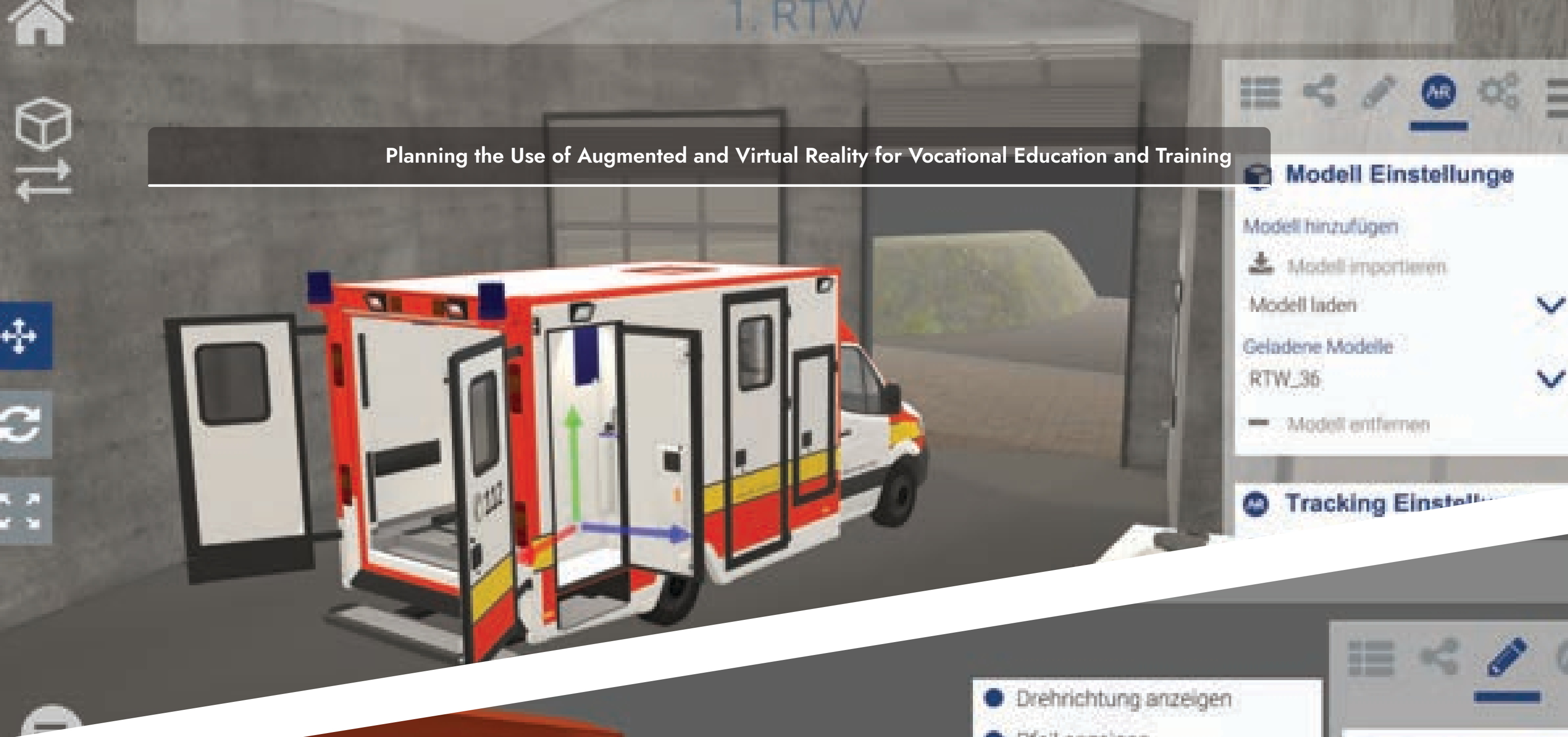
Which technical constellations are deployed

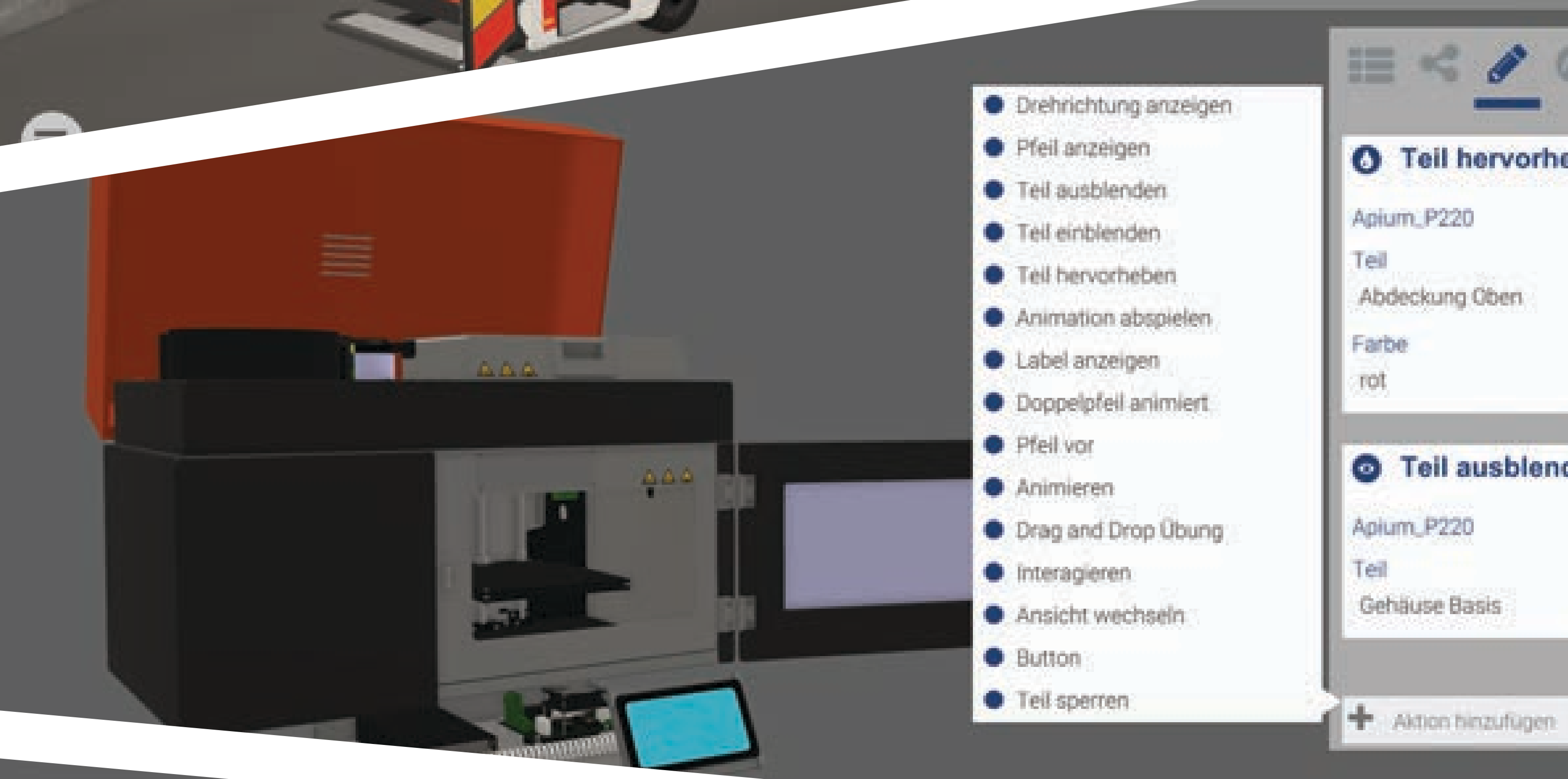
In many cases, these authoring tools are based on development environments that are commercially available. The most widespread of these currently are *"Unity 3D"* and *"Unreal Engine"*. A broad user community and cost-effective licensing conditions are the main reasons for their popularity.

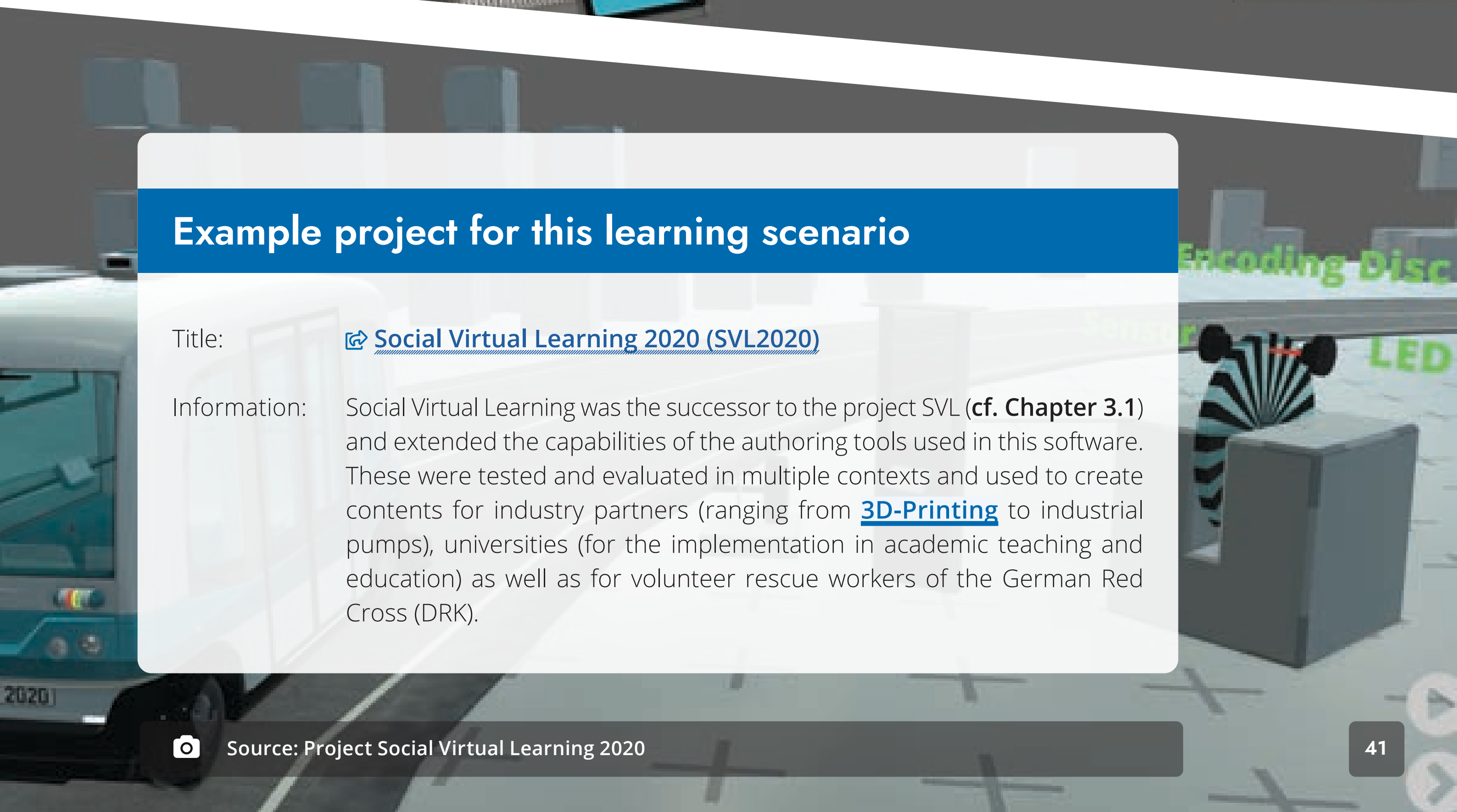


Which learning objectives are pursued? Which didactic concepts are applied?

Authoring tools make it possible to realize manifold scenarios (as described in this publication) even without special software expertise. As such, a wide variety of learning objectives and didactic concepts can be implemented, depending on the individual use case.







Example project for this learning scenario

Title: [Social Virtual Learning 2020 (SVL2020)]

Information: Social Virtual Learning was the successor to the project SVL (**cf. Chapter 3.1**) and extended the capabilities of the authoring tools used in this software. These were tested and evaluated in multiple contexts and used to create contents for industry partners (ranging from 3D-Printing to industrial pumps), universities (for the implementation in academic teaching and education) as well as for volunteer rescue workers of the German Red Cross (DRK).

Source: Project Social Virtual Learning 2020

BILT
Bridging Innovation and Learning in TVET

The Bridging Innovation and Learning in TVET (BILT) project provides TVET stakeholders with a platform for exchange and supports them to address current challenges in TVET systems, which arise due to technological, social, environmental, and workplace changes. Within BILT, the overarching theme is New Qualifications and Competencies in TVET, which is supported by four focus themes in the context of TVET:

- Digitalization
- Greening
- Entrepreneurship
- Migration

Through regular knowledge exchange, thematic project activities, and expert working groups BILT leverages the existing mechanism of the UNEVOC Network to offer opportunities for collaboration and peer learning in Europe, Africa, and Asia and the Pacific. The project complements national developments to explore and support innovative, market-oriented and attractive modes of learning and cooperation in TVET.

The results of ongoing activities are accessible on BILT's web page:
www.unevoc.unesco.org/bilt

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