VETToolbox

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# The use and implementation of XR in VET teaching, a practical guide

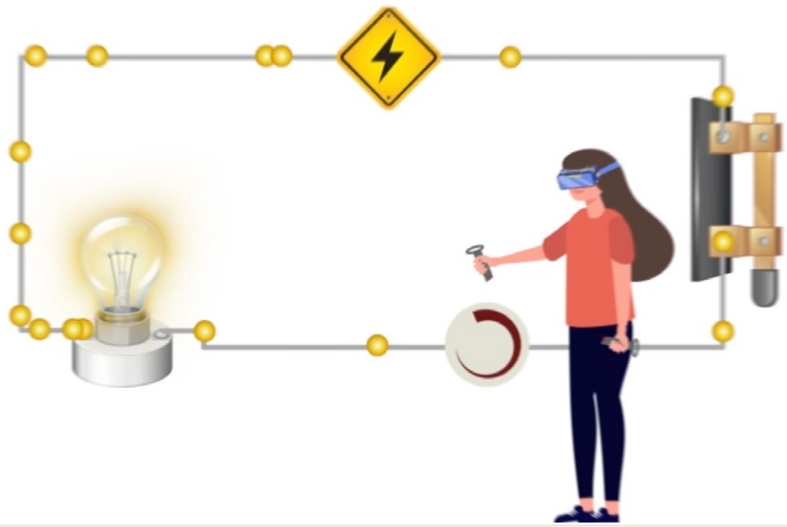
# Manual

Implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

## Contents





# 1. Introduction

In this first chapter you will get a comprehensive introduction to XR technologies and what each of them are. Also, you will get an insight into the findings of the stocktaking report which was conducted prior to this manual to assess the current situation of XR usage in VET training and formed the basis of this manual.

## 1.1 Introduction to XR technologies

XR stands for extended reality and is an umbrella term for immersive technologies.

"[...] All immersive technologies extend the reality we experience by either blending the virtual and 'real' worlds or by creating a fully immersive experience."[1]

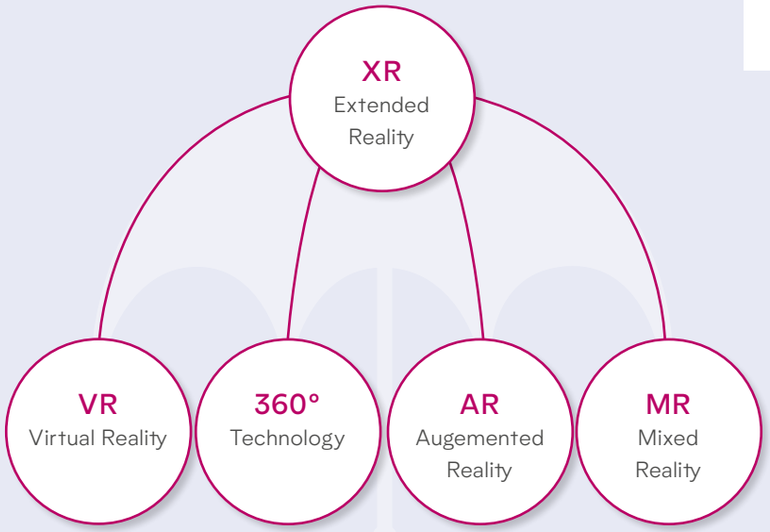



**Figure 1**
Umbrella term Extended Reality

1 Laan, José / Verweij, Sandra: XR Technologies for industrial SMEs. The VAMR*s University-Business Cooperation Handbook (Project: VAM Realities), Fachhochschule des Mittelstands (FHM) GmbH University of Applied Sciences, Germany, 2022. p.6

## 1.1 Introduction to XR technologies

When reading about XR technology you will notice that different sources have a slightly different understanding and definition of the terms. In the following we will try to give a comprehensive overview that defines each of the technologies as clearly as possible. Because this is a relatively new field, definitions are still rather fluid and unclear.

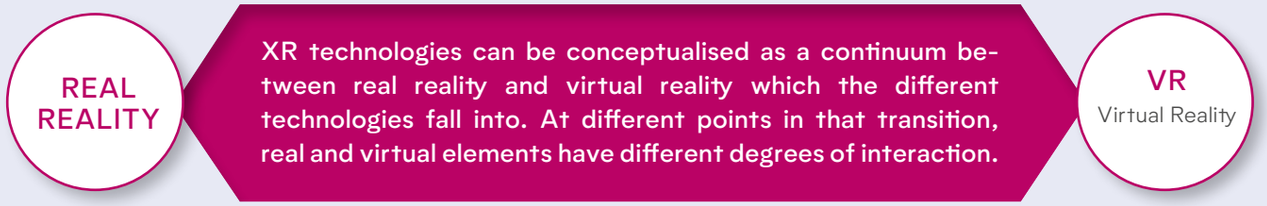
The different technologies vary in their degree of immersion. Immersion describes "becoming completely involved in something"[2] . In XR, immersion means that the user is not just an outside observer but a part of and participating in the (learning) experience. This offers the opportunity to acquire experience-based rather than theory-based knowledge. Through immersion, it is also possible to practice processes that would be difficult or dangerous to practice hands on in real life. Immersive learning triggers emotional response, which motivates learners and enables them to remember processes easily. It increases motivation, confidence and (job) preparedness. Last but not least, new and innovative tools further boost motivation and learning willingness (as does diversity in methodology.)

One important term to know with regards to XR is **"degrees of freedom"**. Degrees of freedom (DOF) refers to the amount of flexibility and freedom of movement on the directional axes a user is given within a virtual environment. DOF determines whether the user can move or manipulate things along those same axes.

True VR would include the stimulation of all 5 senses (taste, sight, smell, touch, sound). Realistically the most common VR solutions make use of at least 2–3 senses (touch, sight, sound). Simulators even incorporate other senses such as vibration, movements; jerks which makes the experience even more immersive and "real" for the user.

In the following part you will receive an overview over XR technologies and how they differ from each other.

**Figure 2**
XR technologies have different degree of immersion




2 https://dictionary.cambridge.org/dictionary/english/immersion

## 1.1 Introduction to XR technologies

### XR technologies: an overview

| | Virtual Reality (VR) a | 360° Technology b | Augmented Reality (AR) c | Mixed Reality (MR) b |
|---|---|---|---|---|
| DEFINITION | Virtual reality is a fully immersive environment that is entirely built in the virtual world. This can be based on an animated environment or actual video footage that places the user in a 3-dimensional environment that they can move in and interact with through VR-goggles and handheld controllers. | 360° is usually produced by or with filmmakers – once it has been produced, it cannot be changed easily. The story is scripted and cannot be influenced by the users. | AR is an enhanced version of reality.<br><br>In AR, virtual elements are added to the reality of the user. They are visible through devices (e.g., a phone screen). | MR combines augmented aspects and the real environment in an even more interactive way than AR. It allows for more interaction between augmented aspects and reality.<br><br>For example, while an AR application will be able to place a ball on a table, a ball in an MR application will roll off an uneven table and bounce off the floor. |
| DEGREES OF FREEDOM | 6DoF means that the technology can track whether the user has moved forwards, backwards, sideways, or vertically in the 3-dimensional space in addition to rotational and tilting head movements, i.e., orientation tracking (rotation) and positional tracking (translation) is possible. | 3DoF means that the technology can track whether the user has turned their head left or right, tilted it up or down, or swivelled it left or right, i.e., orientation tracking (rotation) is possible, but translational movement in the environment is impossible. | DoF does not apply here, because the user is not positioned in a virtual environment, but the virtual aspects are superimposed over the real reality. | DoF does not apply here, because the user is not positioned in a virtual environment, but the virtual aspects are superimposed over the real reality. |

## 1.1 Introduction to XR technologies

| | Virtual Reality (VR) a | 360° Technology b | Augmented Reality (AR) c | Mixed Reality (MR) b |
|---|---|---|---|---|
| IMMERSION | High<br>VR has a high level of immersion as the user is completely immersed in the virtual world and can interact within it. | Medium<br>360° has a medium level of immersion as the user is placed in a virtual scenario but possibilities for movement and interaction are limited. | Low<br>AR has a low level of immersion. It enables users to keep interacting within the physical world around them, but virtual items appear to be part of the real world. | Low<br>MR as AR has a low level of immersion as the user is not fully immersed in a virtual environment, but virtual items appear to be part of the real world. |
| INTERACTIVITY | High<br>The interactivity in VR is high and should offer all the freedom real reality offers. This is still not always the case, the user can for example only interact with objects that are programmed to be interactive. | Low/Medium<br>In 360°, users cannot influence the script. Interactivity is therefore limited.<br>360° photo tours offer a more individualised learning path and higher level of interactivity.[3] | Low/Medium<br>AR technology offers some level of interaction to the user, such as rotating objects or placing them. Often, information or imagery are simply layered over reality and are not interactive. | Medium<br>MR offers more interaction between virtual objects and the real world.<br>MR enables users to manipulate and communicate with virtual and physical environments or objects through high-level imaging and sensing technologies. |

**Supplement table, XR technologies**

a https://www.oxfordlearnersdictionaries.com/definition/english/virtual-reality?q=Virtual+reality (15.08.2022)
Laan, José/Verweij, Sandra: XR Technologies for industriel SMEs. The VAMR*s University-Business Cooperation Handbook (Project: VAM Realities), Fachhochschule des Mittelstands (FHM) GmbH University of Applied Sciences, Germany, 2022. p.6

https://www.iotforall.com/difference-between-vr-ar-mr-360 (20.09.2022)

b Federal Institute for Vocational Education and Training (BIBB): *Planning the Use of Augmented and Virtual Reality for Vocational Education and Training, A Practical Guide*, Bonn, 2021. p.5

c https://www.oxfordlearnersdictionaries.com/definition/english/augmented-reality?q=Augmented+reality (15.08.2022) /
Laan, José / Verweij, Sandra: XR Technologies for industriel SMEs. The VAMR*s University-Business Cooperation Handbook (Project: VAM Realities), Fachhochschule des Mittelstands (FHM) GmbH University of Applied Sciences, Germany, 2022. p.6

## 1.1 Introduction to XR technologies

| | Virtual Reality (VR) a | 360° Technology b | Augmented Reality (AR) c | Mixed Reality (MR) b |
|---|---|---|---|---|
| USE CASES | Job training for dangerous situations and with expensive or unavailable equipment.<br><br>Collaborative virtual spaces (metaverse).<br><br>Interactive soft skill trainings. (VR/360°) | Immersive 360° videos.<br><br>Interactive learning formats where information and content are embedded in hotspots within a 360° scenario (photo). | AR Cube (Merge Cube)<br><br>Technical remote support for training and technical jobs.<br><br>Google live translation | The development of actual use cases is still in process. MR technology will combine AR and VR in such a way, that virtual items can be interacted with. |
| TOOLS | **VR glasses**<br><br>VR glasses have a stereoscopic view which means there are two different images for each eye.<br><br>They contain motion trackers to measure the user's movement and come with a set of handheld controllers for interaction within the virtual environment. | VR glasses, cardboard glasses, computer/ smartphone screen<br><br>**Cardboard glasses** are simple foldable cardboard boxes into which a smartphone can be inserted. The user watches what's on the phone. The video watched must have a stereoscopic viewing option.<br><br>On **computer-/smartphone screens**, a 360° video can also be watched, the user can look around the environment by clicking and dragging or swiping the screen. | Smartphone screen and camera, AR glasses, AR cube<br><br>**AR glasses** offer the user a view of their real environment (unlike VR) and overlay it with augmented aspects.<br><br>An **AR cube (Merge Cube)** is a cube either printed and folded from paper or from plastic with patterns printed on each side. With the corresponding apps, the phone camera projects 3D objects onto the cube. | **MR glasses**<br><br>MR glasses are similar to AR glasses, as MR technology also uses real reality as a foundation the user can see through the glasses and augmented aspects layered over the real environment. |

## 1.1 Introduction to XR technologies

### What is the Metaverse?

The metaverse mirrors the real world. It is a virtual environment, that users can access with a digital persona, called an avatar, and it ideally offers users all the freedoms reality does. The metaverse can function as a collaborative environment or a meeting space, and it can offer market-places or gaming experiences. The term “Metaverse” is still rather broad and un-defined as it is still in the making. For now, and in the VET context, we can imagine a virtual space in which I can move around, meet others, access learning materials, hold meetings, and collaborate.

## 1.2 Key findings from stock-taking report

**XR provides great opportunities to enhance and complement learning and training in VET. In a nutshell:**

- Major benefits of XR are safety and reduction of risks for users and equipment, as well as inducing high levels of motivation and likely better learning outcomes for users.
- If XR is planned and implemented effectively, ongoing costs within VET can be reduced.
- Experiences show that VET-practitioners and learners have responded positively to training with XR.

**It is pivotal to not only spark enthusiasm with IT staff, but all.**

- Teachers and trainers are key for making XR use effective and sustainable. They need to be taken aboard when XR projects are developed.
- Information, training, and ongoing technical support for VET personnel are crucial for the sustainable and effective implementation of XR technology in the sector.
- Best overall results may be achieved when XR is integrated into the VET system by incorporating it into curricula and tailoring it towards occupational standards.
- Linking XR training to curricula for teachers and trainers to be able to learn its use and work with it in their regular working time and environment is of great impor-tance.
- An eco-system-approach brings the political level, the private sector, VET man-agements and administration, VET trainers, development partners and potentially employers’ and workers’ organisations together to make XR relevant and success-ful in the specific context.

## 1.2 Key findings from stock-taking report

- Training staff on use of XR is the most cost-effective way to implement XR use.
- Decision makers and VET management and administration need to understand and support XR endeavours to provide an enabling environment for its implementation.

**Immersion and enhancement of reality are important tools in providing state-of-the-art teaching and training in VET.**

- XR has the potential to positively change the perception of VET – state-of-the-art technology use in VET can help bring about the image shift needed in many contexts.
- Context-specific needs should be considered for the design and implementation of XR projects. Hence, decision making on whether applying XR or not should be context-specific and needs-oriented.
- While XR cannot and is not meant to fully replace in-person training and learning, XR use in VET thus far has shown that trainers/teachers and learners have had positive teaching and learning experiences through XR.
- Moreover, XR is a great tool for inclusion and social integration by enabling learners to participate and achieve good learning outcomes who might otherwise not have been able to be trained at all or not to the same standard.

**Realistic budgeting for XR projects is important for their cost effectiveness especially considering that the production can be quite expensive.**

- Cost-benefit analysis should be undertaken before designing and implementing XR technologies. Sometimes the introduction of XR is too expensive compared to its benefits.
- XR content usually needs to be developed context and sector specifically which is costly and time intensive.

## 1.2 Key findings from stock-taking report

- Ready-to-use content for VET is still scarce or expensive and does not fully fit the individual context and occupation.
- Building up an XR unit in the local context, e.g., as part of the Ministry of Education, can be sustainable and cost-effective in the medium to long term, as content can be continuously developed, added, and re-used based on national curricula and occupational standards.
- As XR content is relatively easy to translate, it is possible to reuse content for similar contexts in different languages.
- When duration and complexity of XR project execution and implementation are taken into account, more realistic project planning can be undertaken. Enough time for implementation and training should be allocated.
- Logistics management, maintenance, repairment and continuous technical support should not be forgotten when planning XR projects, as they are ongoing tasks for which personnel and budget need to be allocated.

### Fulfilling some infrastructure requirements is key for XR use.

Whether XR use makes sense in a specific context is determined on the simplest level by the question whether electricity supply and ideally stable internet connection are available. Without these preconditions, XR use might not be suitable.

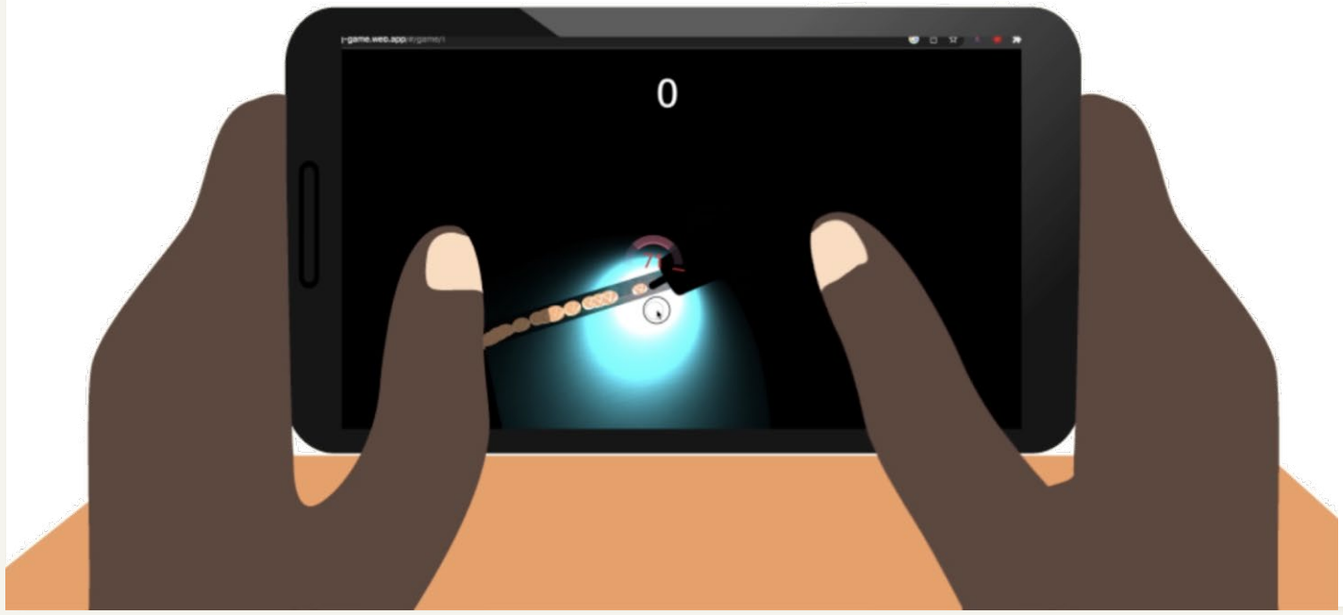
# 2. XR in Learning and Teaching:

## The advantages and challenges of immersive learning

In this chapter you will find an overview of advantages and disadvantages of XR technologies so you can start to assess your own situation and how the implementation of XR technology could benefit you and the learners in your context.

| ADVANTAGES | CHALLENGES |
|---|---|
| → Opportunity for individual learning in one's own space, time, pace | → A stable energy supply is a precondition |
| → Enhancement of learning outcomes through immersion via XR | → A stable internet connection is necessary for many of the applications |
| → Some low threshold applications are for free or very low-cost | → The development of individual VR applications can be quite expensive |
| → Repetitions in a safe space are possible as often as necessary (e.g., with VR) | → There are also costs for maintenance, technical assistance and backstopping, repair, and ongoing training of new personnel if a new app / technology is introduced |
| → High Motivation of the students for XR methods | → Acquisition, storage, distribution, collection, and maintenance of the technology must be organised in the long term (needs human and financial resources) |
| → Possibility of opening black boxes for students (e.g., looking into an engine with the help of AR) | → The use and the development of XR applications often needs some technological know-how (or at least interest) |
| → Safety and reduction of risk for users and equipment (e.g., dealing with height, dangerous materials, difficult processes) | → Existing XR applications might not be context- and/ or sector-specific and fit well into the national occupational standards and curricula |
| → Sustainability (e.g., saving resources by using less consumables) | → The XR equipment is fast evolving. This might be a challenge when implementing a new technology during a longer period of time |
| → Possibility to train without expensive material (e.g., in rural areas with insufficient equipment) | → The development and implementation of context specific XR applications can be quite complex and can last quite long |
| → Good for training in contexts in which many people share limited space / resources | |
| → XR adds diversity of teaching and training methods | |
| → Students with learning disabilities seem to have great gains from learning with XR (e.g., if the training centre is far away and access is difficult) | |

| ADVANTAGES | CHALLENGES |
| --- | --- |
| → Possibility to translate the content of the XR application, so that people with different languages can use it<br>→ Students can gain confidence in a protected learning space (e.g., if they never had / have the possibility to experience the workplace before)<br>→ XR goggles can be used for different content and subjects<br>→ The costs to produce VR content and to acquire VR goggles can be perceived as manageable considering the impact (this depends on the project) | → XR is not able to replace personal live training<br>→ XR modules ideally need to be integrated into a pedagogical framework<br>→ Some people feel frightened by the immersion or feel motion-sick initially |



# 3. How to implement XR technologies in learning environments

## 3.1. What equipment do I need for the implementation?

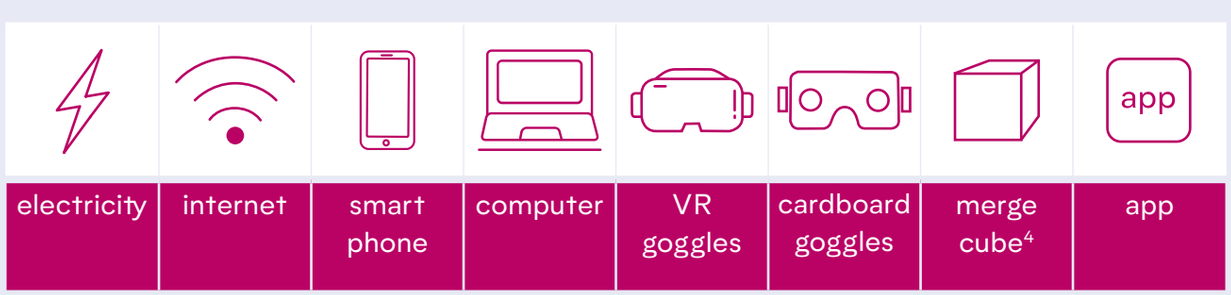
In the following chapters you will be introduced to practical guidelines for implementation of different XR technologies. Therefore, we will give you a short introduction to how to prepare the implementation of XR technologies into your lessons, the technical requirements, and different teaching styles. These aspects will come up again in the later guidelines.

### Will the technology help me reach my learning goals?

Before implementing any type of technology into the framework of a lesson, the learning goals need to be defined and the technology's potential to facilitate and support the reaching of that specific learning goal needs to be determined. Of course, this is also true for XR technologies. If the technology supports the learning path and improves the outcome of the lesson in some way it is worth thinking about its implementation.

Please have a look at the overview of symbols used in the following chapters regarding technical requirements for the use of the respective XR technologies:

**Figure 3**
Overview of symbols for the use of the respective XR technologies




3 This technology will be explained more in the chapter on the merge cube.

## 3.2. What types of teaching/learning approaches are there?

In the following overviews and practical guidelines, you will get an insight into which teaching format the respective technologies can be used in. As a short preparation check out this short summary of the teaching formats:

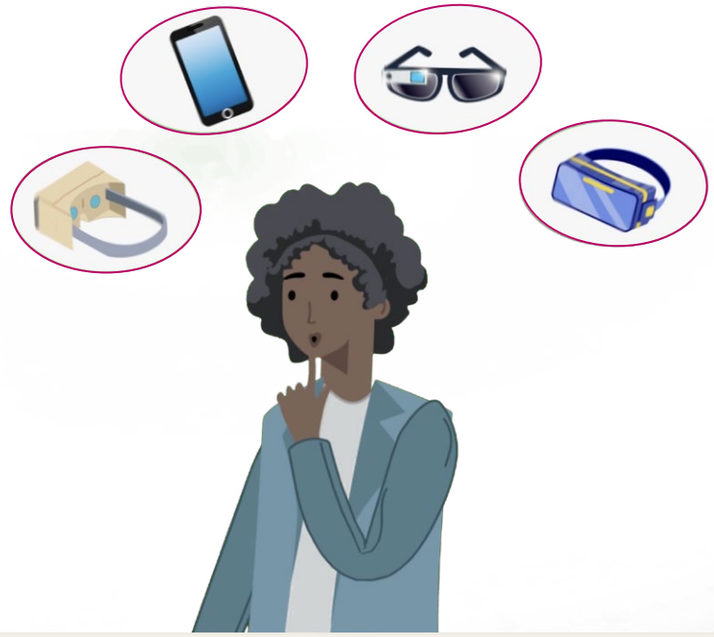
- **Classroom learning** (synchronous) describes the classical teaching style where the teacher and the learners are in the same place (traditionally a classroom) at the same time. Therefore, we also speak of a synchronous teaching style in this case, as teaching and learning is happening at the same time for all participants.

- **Remote learning** (asynchronous) describes a teaching style, in which prepared materials are provided to learners online, and the learning process takes an individual path. Each learner can study and practice on their own time, watch or read materials multiple times and work on tasks freely. Therefore, this teaching/ learning style is asynchronous: the teaching and learning is not happening at the same time, in the same place.

  An e-learning platform for example, where participants access modules and lessons on their own accord, where they can solve tasks, quizzes, and tests on their own time, would be an example for remote learning.

- **Blended-Learning** approaches combine synchronous and asynchronous components. Online educational materials are combined with classroom teaching where the teacher and learners come together in the same place. The online, computer-mediated components replace some of the in-person teaching.

  Some aspects of training can for example be done at home on a computer and results and questions can be discussed in class.



## 3.3 How can I integrate XR technologies with a limited number of VR goggles? Pedagogical method: Learning stations

One pedagogical method that is useful when implementing technology that is potentially expensive and therefore only available in limited numbers is “station learning”.

When you want to use technology such as VR-goggles in a classroom setting with larger groups, there might only be a few goggles for 30 people. For each learner to have the opportunity to use the VR-goggles at least once, the classroom can be set up with different learning stations. Each station contains different input or tasks. Keep in mind, that the stations should not have to be worked on in a specific order or build on one another because each station will be occupied at the same time so each group will start at a different station.

If you are teaching a class on the job profile of a car technician in a medium sized workshop and want to implement a 3 minute long 360° video about a specific repair workshop for cars, which learners are supposed to watch on VR goggles, you might integrate it into the following framework of workstations in the classroom:

**Station1 – computer research**
In a small group, learners research some important facts about the job profile of someone working in a car repair workshop and make a list of skills they think are necessary for that job.

**Station 2 – brainstorming: what are my skills**
In their small group, learners think about their own skills, what they are good at, what they are interested to learn, what is not interesting for them and so on. They can also give each other feedback on what they think the others would be good at. To provide some more guidance at this station, the teacher/trainer can provide lists of sift skills and hard skills which the learners pick from or make a ranking for themselves.

**Station 3 – VR goggles: an insight into the workshop**
In their smaller work groups, the learners now use the VR goggles. Depending on how many goggles are available they might all watch the video at once or one after another. If some students must wait before putting on the goggles, there should be a reflective task they can work on in the meantime (What are my expectations? Do I think this job could be for me?).

**Follow-Up in the big group**
After each group has worked on each station, there should be a follow-up where learners can give their feedback and share their thoughts on their experiences and the technology.

- What did I learn?
- What did the technology add to the experience?
- Is the job profile what I expected it to be?
- Does the job profile fit my interests and skills?
- What skills would I need to work on to be able to work in this field?

## 3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

In the following chapter, you will be introduced to different XR tools and their usage. You have already learnt about teaching styles and pedagogical concepts for the implementation of XR tools. Now, you will get an idea of what the implementation of each tool entails.

The tools are structured into three categories:

1 **Low budget** tools, that are relatively easy and cost-efficient to implement. Cost-efficiency also means, that a big network of specialists is not needed but everything can be prepared and implemented by the teacher themselves. Initially, this might lead to more time investment on the teacher's part, but you will see that the tools are not that hard to understand.

2 Tools for a **medium budget**, which entail a bit of an initial investment, offer more interesting XR solutions and will need less of a time investment on the teacher's part.

3 Tools for a **large budget** with a significant amount of financial and time investment and development of XR content for a specific context and learning goal.

For each XR tool, you will find a general overview of what type of classroom setting it can be used in, what the time expenditure roughly is, what equipment is needed, and what the costs are. The general overview is followed by a step-by-step guide that you can follow if you want to implement this tool into your classes, followed by a check list which can help you assess if you are ready for the tool.3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

## 3.4.1 What can I do with a small budget?

### MERGE CUBE

The merge cube can be bought in plastic or printed out on paper and glued together. The cube has markings on each side, which the camera phone scans. With a corresponding app, objects can be viewed through the phone screen and rotated by rotating the cube in your hand.

**Social form and remote component:**

| CATEGORIES | Classroom learning | Blended learning | Remote learning |
|---|---|---|---|
| SMALL GROUPS | ✓ | ✓ | (✓) with cube |
| MEDIUM SIZED GROUPS | ✓ | ✓ | (✓) with cube |
| BIG GROUPS | ✓ | ✓ | (✓) with cube |

**Time expenditure:**

**Equipment:**

stable

1/student

**Budget:**

**Partners / Cooperation:**

No partners or cooperations necessary.

Learning goals/needs analysis

Content/ software research

Pedagogical implementation

Follow-up

Checklist

3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

## 3.4.1 What can I do with a small budget?

**360° – PHOTO TOUR**

360° technology can be very elaborate and almost as refined as VR technology, lacking some of VRs interactive aspects. However, there are simple use cases that can be applied with a small budget and little to no experience. During COVID, 360° photo tour technology was used in the real estate business, to offer customers virtual tours through apartments and houses.This technology can also be used to transfer knowledge and give learners an insight into environments like workshops or labs. With google street view anyone can make a 360° photo of one or more rooms/environments and free software to overlay these photos with video, photo, audio, or text material by inserting clickable hotspots into the photos.

**Budget:**

**Partners / Cooperation:**

No partners or cooperations necessary.

**Learning goals/needs analysis**

**Content/ software research**

**Pedagogical implementation**

**Follow-up**

Checklist

**Social form and remote component:**

| CATEGORIES | Classroom learning | Blended learning | Remote learning |
|---|---|---|---|
| SMALL GROUPS | ✓ | ✓ | (✓) with cube |
| MEDIUM SIZED GROUPS | ✓ | ✓ | (✓) with cube |
| BIG GROUPS | ✓ | ✓ | (✓) with cube |

**Time expenditure:**

**Equipment:**

stable | 1/student | (1/student), 1/teacher

3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

## 3.4.2 What can I do with a medium budget?

### SOFTWARE WITH READY-TO-USE XR CONTENT

There are platforms where already developed XR-content can be downloaded and used. Two examples, each with a different thematic focus are the platforms “Bodyswaps” and “Immerse”.

**Bodyswaps** is a platform that offers XR applications (for VR goggles, PC, and mobile phones) in which students can use soft skill trainings for job interviews and appropriate behaviour at work (communication, teamwork, and leadership skills). The platform offers trainings on public speaking and presenting, job interviews and giving feedback (available in English and French).

**Immerse** offers VR trainings in fields such as hazard awareness, health, and safety, working at high altitudes, electrics, mining, energy, technical training, diversity and inclusion, well-being, and medical emergencies. Trainings are available in English, French, Spanish, and some in Portuguese. Most trainings are developed for the use of VR goggles, but many can also be accessed from a desktop computer. The aim of both platforms is to give students the opportunity to learn in a safe environment, so that they become more self-confident in their skills.

**Social form and remote component:**

| CATEGORIES | Classroom learning | Blended learning | Remote learning |
|---|---|---|---|
| SMALL GROUPS | ✓ | (✓)[5] | (✓) |
| MEDIUM SIZED GROUPS | ✓ | (✓) | (✓) |
| BIG GROUPS | ✓ | (✓) | (✓) |

**Time expenditure:**

→ Research of suitable material

→ Getting to know the platform

**Equipment:**

icons

stable | 1/student | 1/student, 1/teacher (or)

**Budget:**

4 Blended learning and remote learning options are possible but if learners are supposed to use the technology by themselves at home more devices are needed and a guide on how to use the technology successfully must be provided.

3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

## 3.4.2 What can I do with a medium budget? ▶ Software with ready-to-use XR content

**Partners / Cooperation:**

- → Trainers / teachers as supporters
- → If necessary, funding partners
- → Experts for the technical support (should be provided by the developers if content is bought from a website)
- → Long-term accompaniment
- → Long-term technical support (should be provided by the developers if content is bought from a website)
- → Network of long-term supporters

**Vision/Idea**

**Needs analysis / research**

**Planning the project in detail**

**Organising content and material**

**Embedding content into curriculum**

**Piloting**

**Implemen-tation and sustainability**

Checklist

3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

## 3.4.3. What can I do with a high budget?

**INDIVIDUALISED AND CONTEXT SPECIFIC XR-APPLICATION (designed with experts)**

There are numerous examples of the development of VR apps for the acquisition of certain competences in the field of VET, for example in the field of crafts, agriculture, and soft skill trainings. As the development of VR apps is complex and requires different kinds of specialised equipment and technical know-how, it is necessary to work with various experts. Furthermore, the planning and implementation of such applications is time-consuming. However, if the teacher is not involved in the planning and development, they can use the finished product in the classroom with a moderate amount of effort to learn how to use the technology and little to no time investment for the development. Depending on the number of VR glasses available, the app can be used with different group sizes. If only a few glasses are available, the VR applications can be embedded in a synchronous classroom learning scenario in the form of learning stations. However, in this case the learners must be on site to use the glasses, if more glasses are available, learners can use them at home in a remote learning scenario.

**Social form and remote component:**

| CATEGORIES | Classroom learning | Blended learning | Remote learning |
|---|---|---|---|
| SMALL GROUPS | ✓ | – | – |
| MEDIUM SIZED GROUPS | ✓ | – | – |
| BIG GROUPS | ✓ | – | – |

**Time expenditure:**

- → Project planning & coordination
- → Implementation
- → Content creation from external sources
- → Workshop or Training

**Equipment:**

icons

stable | 1/teacher | 1/student, 1/teacher

**Budget:**

**Further Training:** Usually, necessary

**Language:**

- → 1 language
- → This language can be freely chosen (›› small target group from the same region)

**Partners/ Cooperation:**

- → Trainers/teachers as supporters
- → Funding partners
- → Experts for the design
- → Experts for the implementation
- → Long-term accompaniment
- → Long-term technical support
- → Network of long-term supporters

3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

## 3.4.3. What can I do with a high budget? ▶ Individualised and context specific XR-Application (designed with experts)

**Possible supporters:**

- → Ministries
- → Chamber of Craft
- → Companies, e.g., in the field of technology
- → NGOs
- → Development partners

**Possible experts for VR development:**

Ascent XR | Virtual Reality (VR) and Augmented Reality (AR) Development | Ascent XR

- Vision/idea
- Needs analysis
- Resource check
- Draft planning
- Networking
- Detailed planning
- Development
- Implementa-tion

Checklist

# 4. Case studies/ best-practice examples

Case study 1:

## ASCENT “Alliance for Skill & Capacity ENhancement with Technology” – XR in LMS-based Learning for Groups

OVERVIEW

| | |
|---|---|
| | VET Vocational education and training<br>→ **Healthcare**<br>→ **Logistics**<br>→ **Digital Technologies** |
| | 01.03.2022 – 28.02.2026 |
| | India: Across 9 states in India |
| | Enhancing the employability of India’s youth in the allied sectors healthcare, logistics and digital technologies and to contribute to a sustainable Vocational Education Training (VET) ecosystem in India. |
| | → At least 150 teachers/trainers (›› to be trained), 75 from within SMART academies and 75 from ITIs and NGO partners<br>▼<br>→ 10,000 urban youths (›› final target group) |
| | → Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (›› implementation)<br>→ Tech Mahindra Foundation (TMF) (›› Execution) |
| | → GIZ GmbH<br>→ Tech Mahindra Limited (TML) |
| | → German Federal Ministry for Economic Cooperation and Development (BMZ)<br>→ develoPPP where business meets development |
| | → German Federal Ministry for Economic Cooperation and Development (BMZ) |

legend

### Description

→ ASCENT “Alliance for skill and capacity enhancement with technology” is a joint project commissioned by the BMZ, implemented by the GIZ & Tech Mahindra Foundation.

→ The objective is to train 10,000 urban youths to become skilled professionals and help them find jobs in healthcare, digital technologies and logistics benefitting marginalised groups (35 % of the enrolled youth who need financial assistance receive scholarships or sponsorship schemes, wherever deemed fit).

→ The program is supposed to enhance the teaching/learning experience of participants by employing technological interventions including Augmented Reality/ Virtual Reality (AR/VR) curricula as well as online learning.

→ For this purpose, a comprehensive Atingi based skills training is being developed.[6] The Atingi based learning has two main pillars: The self-paced theoretical e-learning/blended learning and an XR-component.

5 **Atingi** is the LMS of the GIZ which is open source.

## Case study 1: | ASCENT “Alliance for Skill & Capacity ENhancement with Technology” – XR in LMS-based Learning for Groups

**Description** (continued)

- → There are 250 AR- & VR-modules on Atingi so far. The content is a mixture of VR content, 60 % hybrid modules and 20 – 25 % AR modules.
- → A job portal is going to be developed. Individualised online learning and training is complemented by live online sessions with master trainers.
- → The kick-off for the implementation was only in March 2022, so there is no implementation experience thus far. Currently, the implementing parties are assessing which equipment is needed by the students (smartphones, tablets). The cost for equipment is covered by Tech Mahindra as the corporate partner.
- → There are already small hubs all over India which are equipped with practical labs. These labs will also be equipped with VR-gadgets and tools as part of the project.
- → Cooperation with consultants for the development of the content, especially for digital/XR content were necessary.
- → Sustainable linkages with 300 industry partners are established through outreach, advocacy, placement aggregation, and job portal development (for the healthcare sector).
- → There has been a close cooperation with teachers/trainers/master trainers.
- → The long-term-goal is to contribute to a sustainable VET ecosystem, through capacity building of trainers with improved pedagogy and technical training.
- → Collaboration with the Directorate General of Trade (DGT), to train selected Industrial Training Institute (ITI) trainers and provide them access to e-content developed under the project for various courses.

**Relevance and innovative approach**

Product

- ✓ Content for Atingi (›› Learning Management System of GIZ)
- ✓ Production of 250 AR and VR modules
- ✓ Composition:
  15 – 20 % VR content
  60 % Metaverse (hybrid module)
  20 – 25 % AR modules
- ✓ Job portal is going to be developed

Specialties

- ✓ Working with clusters (cluster = grouping of actors who are active in the same field, even if they take on different roles
- ✓ Working with an LMS like Atingi
- ✓ Combining XR-Tools with real-life learning with master trainers

## Case study 1: | ASCENT “Alliance for Skill & Capacity ENhancement with Technology” – XR in LMS-based Learning for Groups

**Success factors and learnings**

- ✓ Learning opportunities with limited resources (›› such as tools, machines, objects)
- ✓ Training many people in different places
- ✓ Students can practice on their own time and at their own pace

## Case study 2:

### VR Skills Lab & Tower Crane Training - XR in Craft Professions

OVERVIEW

**Electro distribution**
VET Vocational education and training
(for VET high school students)
→ VR simulation for control and maintenance of electrical installations: Maintaining electrical installations

**Construction**
Certified Training Centres (for adults)
→ VR simulation for tower crane operators: Operating a tower crane

VR Skills Lab: August 2021 – June 2022

Tower crane training: June 2022 – December 2022

North Macedonia

→ Teachers/trainers (›› to be trained)
▼
→ VR Skills Lab:
Students of five schools (North Macedonia)
→ Tower crane training:
2 governmentally certified companies that run training programmes for adults

VR Skills Lab
→ Blink 42 – 21 Centre for Social Innovations
→ International Labour Organization (ILO) (›› support)
→ High schools

legend

VR Skills Lab
→ International Labour Organization (ILO)

Tower Crane Training
→ Swiss Agency for Development and Cooperation (SDC)

**Description**

→ The VR Skills Lab is a project realised by Blink 42 – 21, funded by the ILO.

→ Within the framework of this project a VR-training tool in electrical installation was developed which was piloted at 5 high schools.

→ The assessment of the technical context and the current status quo, as well as thorough content development for VR-tool were large parts of the project.

→ Part of the project is also the training of users with a focus on teaching and training staff. This includes a Peer-learning approach:

## Case study 2: | VR Skills Lab & Tower Crane Training - XR in Craft Professions

**Description** (continued)

- → The goal is to empower the teachers/trainers who have a high interest in learning to use VR and/or have already relatively high literacy; Those who are more easily and faster acquainted with the technology and convinced by its benefits then work with their peers who need more time and/ or support it or are less intrigued by its use.
- → Practical guide: Another part of the project is the development of a manual for teachers and trainers with pedagogical information and didactical suggestions.
- → The tower crane training was implemented by Blink 42 – 21 and INNOVATO and is funded by the SDC.
- → Development of a VR-training tool in tower crane operation which will be piloted at Certified Training Centres for Vocational Training. This project was built on general learnings and experiences from the first project; hence the focus could be much more on the VR-application and -technology itself.
- → The VR training offers a safe learning environment for learners. No actual equipment (tower crane) is needed, and the learners are not at risk to injure themselves or others.

**Relevance and innovative approach**

Product

- ✓ 1 VR application in the field of electric installations
- ✓ 1 VR application to train the operation of crane towers

Specialties

- ✓ Creation of a manual for teachers
- ✓ Combining XR-Tools with real-life learning (blended learning)
- ✓ Peer-Learning (teachers of different age working together)

**Success factors and learnings**

- ✓ VR applications as a safe learning environment for students
- ✓ Students can repeat the task and practice several times at their own pace
- ✓ Possible cost benefit if the app is developed: reduction of material and waste as the students only use the materials virtually

## Case study 3:

### TVET System Reform (TSR 2.0) – XR Soft skill Training in TVET

| OVERVIEW | |
|---|---|
| | Reforming the TVET System in Indonesia<br>→ Piloting in: Hospitality & Tourism<br>→ restaurant/reception<br>→ hotel kitchen |
| | 2018 – 2021 (first project)<br>2021 – 2024 (second project) |
| | Indonesia |
| | → Teachers/trainers (›› to be trained)<br>▼<br>→ Young people in TVET schools<br>→ (TVET) institutes for VR content creation<br>→ Hotel association and its training centre |
| | → GIZ<br>→ Ministry for Economic Affairs Indonesia (Institutional partner)<br>→ Studio2B (subcontractor for the XR elements)<br>→ Indonesian Chamber of Commerce and Industry (KADIN)<br>→ Ministry of Education, Indonesia<br>→ National government institutions |
| | → German Federal Ministry for Economic Cooperation and Development (BMZ) |
| | → German Federal Ministry for Economic Cooperation and Development (BMZ) |

legend

**Description**

→ Technical and Vocational Education and Training System Reform (TSR 2.0) is a project implemented in Indonesia by the GIZ, the coordinating Ministry for Economic Affairs and commissioned by the BMZ.

→ Within the framework of this project, four VR Soft-Skill-Trainings have been developed, three for the hospitality industry (reception, restaurant), as well as one VR learning scenario focussing on technical skillsets within a hotel kitchen which are piloted in 16 vocational high schools.

→ Within the project, there have been two lines of intervention:

→ Content creation including several feedback loops on technical and pedagogical aspects to generate acceptance by teachers, students, and the private sector, and thus a sustainable set-up.

→ Piloting of VR-equipment with interactive training for the hospitality sector in schools.

→ A three-fold approach was applied:

## Case study 3: | TVET System Reform (TSR 2.0) – XR Soft skill Training in TVET

**Description** (continued)

→ Creating a common understanding of VR among all relevant stakeholders in the local TVET-sector on the national level with the aim of decreasing hesitation, resistance, and knowledge gaps by showing the use in other countries and by demonstrating the advantages for teachers.

→ Conducting visits & trainings to the TVET-schools in the provinces which received the VR-equipment. Part of these trainings was a technical introduction and a pedagogical training on how to use the material in class.

→ Establishing a backstopping framework with service providers (companies) with the aim of providing direct support with technical glitches and insecurities as well as for the VR content development/creation.

**Relevance and innovative approach**

Product

- ✓ 8 TVET VR-training modules developed by local (TVET) institutes
- ✓ 1 VR application for soft skill training in the restaurant
- ✓ 2 VR application for soft skill training at the reception
- ✓ 1 VR application for the training of technical aspects in the hotel kitchen
- ✓ 3 TVET VR-training modules for Hygiene and food safety in Hotel and Restaurant

Specialties

- ✓ Intensive technical teacher training
- ✓ Regular Check-In with teachers in bilateral meetings and support
- ✓ Pedagogical training on how to use the material in class

**Success factors and learnings**

- ✓ For lots of students it is the first time to experience the future work environment
- ✓ Students can practice dealing with conflict situations in a safe learning environment
- ✓ Since internships cannot be realised everywhere, the apps allow young people to have experiences, they would otherwise not have at all

## Case study 3: | TVET System Reform (TSR 2.0) – XR Soft skill Training in TVET

@ GIZ Indonesien/ Philipp Johannsen


@ GIZ Indonesien/ Philipp Johannsen


@ GIZ Indonesien/ Philipp Johannsen

# 5. OER materials

For more information on the merge cube and to check out materials check out the merge website and their guide on how to make your own paper merge cube:

→ Merge Cube | AR / VR Lernen & Erstellen (mergeedu.com)
→
→

To create your own 360° photo tours, check out for example **theasys:**

→ Theasys - 360 VR Online Virtual Tour Creator

Here is a guide on how to take your own 360° photo using the google street view app:

→ Use the Google Street View App to Create 360 Degree Photos – YouTube

For a free VR collaborative experience that you can fill with your own materials check out **Frame VR**, **Virbela**, or **Yulio:**

→ Frame - Immersive Meetings, Classes, Events (framevr.io)
→ Virbela: A Virtual World for Work, Education & Events
→ VR for Architecture & Design – Yulio VR

For some free pedagogical materials on vocational orientation (Language: German) check out the **Dein Erster Tag** website:

→

# Annex chapter 3.4

3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

▶ 3.4.1. What can I do with a small budget?

Answer the following questions. If you don't answer each question with "yes", don't worry and have a go anyway!

**MERGE CUBE** You are ready for this tool!

**Technical requirements**

- ☐ Do you have stable energy supply in the places where the application should be used?
- ☐ Do you have reliable internet coverage in your institution / the places where the users would apply the XR-application?
- ☐ Do you and the students have the necessary equipment, in this case smartphones and a printed-out merge cube or the plastic version?
- ☐ In case you want to use specific software/apps, do you have the possibility to access this software (licences) and the digital competence to make it work on different devices? If not, can you get technical support to help you with this and give you and other users an introduction? A YouTube video might be enough to learn the necessary skills.

**Pedagogical/ Human Aspects**

- ☐ Do you have time / resources to assess your sector specific needs and learning goals before starting the implementation of the Merge Cube?
- ☐ Do you have time / resources to plan the implementation and research suitable software for the Merge Cube that fits the learning goals?
- ☐ Does your idea for the XR application bring an added value to the teaching of the curriculum of the vocational and educational training?
- ☐ Do you as a trainer/teacher see a benefit for the students and yourself in using this tool?
- ☐ Do the learners perceive a benefit for themselves in using this tool?
- ☐ Are you as a trainer/teacher open and motivated to learn more about the technology and to implement it in the frame of your work?

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3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

▶ 3.4.1. What can I do with a small budget?

Answer the following questions. If you don't answer each question with "yes", don't worry and have a go anyway!

**360° – PHOTO TOUR**

You are ready for this tool!

**Technical requirements**

- ☐ Do you have stable energy supply in the places where the application should be used?
- ☐ Do you have reliable internet coverage in your institution / the places where the users would apply the XR-application?
- ☐ In case you want to work with computers / smartphones / cardboards or VR goggles, do you and the learners have the necessary equipment?
- ☐ In case you want to use a specific software/apps, do you have the possibility to access this software (licences) and the digital competence to make it work on different devices? If not, can you get technical support to help you with this and give you and other users an introduction? A YouTube video might be enough to learn the necessary skills.

**Pedagogical/ Human Aspects**

- ☐ Do you have time / resources to assess your sector specific needs and/or demands before starting the implementation of the photo tour?
- ☐ Do you have time / resources to plan the implementation phase of the photo tour?
- ☐ Does your idea for the XR application bring an added value to the teaching of the curriculum of the vocational and educational training?
- ☐ Do you as a trainer/teacher see a benefit for the students and yourself in using this tool?
- ☐ Do the learners perceive a benefit for themselves in using this tool?
- ☐ Are you as a trainer/teacher open and motivated to learn more about the technology to keep implementing it in your work?

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3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

▶ 3.4.2. What can I do with a medium budget?

Answer the following questions. If you don't answer each question with "yes", don't worry and have a go anyway!

**SOFTWARE WITH READY-TO-USE XR CONTENT**

You are ready for this tool!

**Partnerships:**

- ☐ Do you see a possibility to build partnerships and a network of stakeholders supporting your project?
- ☐ Do you have funding partners, if you need them, for example partners form the private sector, educational or governmental institutions or organisations?
- ☐ Are all partners/stakeholders convinced of the benefits of the technology and its implementation?
- ☐ In case the use of the XR technology is supposed to be embedded in long term project, do you (or other partners) have time/resources to accompany the project on a long-term basis to guarantee the sustainability of the project and the dissemination?
- ☐ Do you (or other partners) have time/resources to accompany the project on a long-term basis to guarantee the sustainability of the project and the dissemination?
- ☐ Do you have experts to contact/cooperate with, who already have experience with the use of the XR applications in a similar context/under similar conditions?
- ☐ Do you have time/resources and a network of supporters to guarantee continuing support for the users to solve technical issues, maintain, update, and potentially repair the equipment and to support and/ or advise trainers and teachers on the continuing pedagogical implementation of the tools?

**Technical requirements**

- ☐ Do you have stable energy supply in the places where the application should be used?
- ☐ Do you have reliable internet coverage in your institution / the places where the users would apply the XR-application?
- ☐ Is there an option to guarantee a safe delivery/storage and maintenance of the technical equipment, which might be of high value?
- ☐ In case you want to work with computers/smartphones / cardboards or VR goggles, do you and the learners have the necessary equipment?

3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

▶ 3.4.2. What can I do with a medium budget? ▶ Software with ready-to-use XR content

**Pedagogical/ human aspects**

- ☐ In case you want to use a specific software/apps, do you have the possibility to access this software (licences) and the digital competence to make it work on different devices? If not, can you get technical support to help you with this and give you and other users an introduction?
- ☐ Do you have time resources to assess your sector specific needs and/or demands before starting the implementation of the XR application?
- ☐ Do you have time/resources to plan the implementation phase of the XR-application?
- ☐ Does your idea for the XR application bring an added value to the teaching of the curriculum of the vocational and educational training?
- ☐ Do you as a trainer/teacher see a benefit for the students and yourself in using this tool?
- ☐ Do the learners perceive a benefit for themselves in using this tool?
- ☐ Are you as a trainer/teacher open and motivated to learn more about the technology to keep implementing it in your work?
- ☐ Are you willing to take part in trainings on XR technology?
- ☐ Are you speaking the language in which the trainings will be held?
- ☐ Does the language of the final users match the language offered in the XR application you are planning to use?

3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

▶ 3.4.3 What can I do with a high budget?

Answer the following questions. If you don't answer each question with "yes", don't worry and have a go anyway!

| | |
|---|---|
| **INDIVIDUALISED AND CONTEXT SPECIFIC XR-APPLICATION (designed with experts)** | You are ready for this tool! |
| **Partnerships:** | ☐ Do you have strong partners and key stakeholders for the design, development, and implementation process? |
| | ☐ Do you see a possibility to build partnerships and a network of stakeholders supporting your project? |
| | ☐ Do you have funding partners, if you need them, for example partners form the private sector, educational or governmental institutions or organisations? |
| | ☐ Are all partners/stakeholders convinced of the benefits of the technology and its implementation? |
| | ☐ Do you (or other partners) have time/resources to accompany the project on a long-term basis to guarantee the sustainability of the project and the dissemination? |
| | ☐ Do you have experts to contact / cooperate with, who already have experience with the use of the XR applications in a similar context / under similar conditions? |
| | ☐ Do you have time / resources and a network of supporters to guarantee continuing support for the users to solve technical issues, maintain, update, and potentially repair the equipment and to support and/ or advise trainers and teachers on the continuing pedagogical implementation of the tools? |
| **Technical requirements** | ☐ Do you have stable energy supply in the places where the application should be used? |
| | ☐ Do you have reliable internet coverage in your institution / the places where the users would apply the XR-application? |
| | ☐ Is there an option to guarantee a safe delivery / storage and maintenance of the technical equipment, which might be of high value? |

3.4. How-To Guide: An Introduction to XR tools for all budgets and how to use them

▶ 3.4.3 What can I do with a high budget? ▶ Individualised and context specific XR-Application (designed with experts)

| | |
|---|---|
| | ☐ In case you want to work with computers / smartphones / cardboards or VR goggles, do you and the learners have the necessary equipment? Do you have the necessary budget? |
| | ☐ In case you want to use a specific software/apps, do you have the possibility to access this software (licences) and the digital competence to make it work on different devices? If not, can you get technical support to help you with this and give you and other users an introduction? |
| **Pedagogical/ human aspects** | ☐ Do you have time/resources to assess your sector specific needs and/or demands before starting the implementation of the XR application? |
| | ☐ Do you have time/resources to plan the implementation phase of the XR-application? |
| | ☐ Does your idea for the XR application bring an added value to the teaching of the curriculum of the vocational and educational training? |
| | ☐ Do you as a trainer/teacher see a benefit for the students and yourself in using this tool? |
| | ☐ Do the learners perceive a benefit for themselves in using this tool? |
| | ☐ Are you as a trainer/teacher open and motivated to learn more about the technology to keep implementing it in your work? |
| | ☐ Are you willing to take part in trainings on XR technology? |
| | ☐ Are you speaking the language in which the trainings will be held? |

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