Guidelines of the digital teaching methodology (Education 4.0)

DEL 3.2 – WP3

EACEA – Erasmus+ Capacity Building in VET, n 101092478 — V.I.R.TU.A.L.

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Summary

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DIGITAL LEARNING

Technology in education initially emerged as a response to the demands of digital natives, a generation accustomed to rapid information access, parallel multitasking, visual-centric learning preferences, and an affinity for online engagement and gamification

1. Digital learning

Traditional pedagogical technologies, unlike digital technologies, are characterized by their specificity (a pencil is used for writing), stability (the use of a blackboard has remained practically unchanged since its invention), and transparency in their function (the way in which a pencil works is directly linked to its function), while digital technologies are protean (used in different ways), unstable (they change rapidly) and opaque (their working is not visible to their users) (Koehler, Mishra, 2009: 61).

Technology in education initially emerged as a response to the demands of digital natives, a generation accustomed to rapid information access, parallel multitasking, visual-centric learning preferences, and an affinity for online engagement and gamification. However, it's worth noting that these traits don't universally apply[1]. The COVID-19 pandemic accelerated the uptake and lived experience of digital technology for teaching and learning, but it also exposed the relative scarcity and basic nature of most digital resources and tools used in education (OECD, 2022[2]; Vincent-Lancrin, 2022[3]).

According Mayer[2], effective learning occurs:

- When words are accompanied by visuals (Multimedia Principle).
- When animations and narrations are used instead of animations alone or written text alone (Principle of Modality).

[1] Digital Natives, Digital Immigrants by Marc Prensky from On the Horizon (MCB University Press, Vol. 9 No. 5, October 2001) © 2001 Marc Prensky

[2] https://www.mheducation.ca/blog/richard-mayers-cognitive-theory-of-multimedia-learning#:~:text=Mayer's%20Cognitive%20Theory%20of%20Multimedia%20Learning%20tells%20us%20that%20the,learning%20rather%20than%20helping%20them

- When redundancy is minimized, favoring animation and narration over redundancy of both (Principle of Redundancy).
- When written text and visual material are presented closely rather than distantly (Principle of Spatial Contiguity).
- When verbal and visual materials are synchronized in time (Principle of Temporal Contiguity).
- When extraneous material is eliminated for consistency (Principle of Consistency).

These principles hold greater significance for students with limited prior knowledge on the subject and those with a visual cognitive style, rather than for those with higher knowledge or non-visual cognitive styles (Principle of individual differences).

Educational contents and pedagogy change when they interact with technology. These changes are precisely what Koehler and Mishra's TPACK model (2009)[3] explains, summarized as follows:

1. Content Knowledge (CK): the knowledge teachers have of the subject they are teaching, i.e. facts, theories, concepts, historical perspectives.
2. Pedagogical Knowledge (PK): the knowledge teachers have about how they are teaching or how they are going to teach. This includes knowing teaching and learning processes, practices and methods, educational goals and values, and also implies knowing how students learn, the techniques and methods to be used, as well as learning theories.
3. Technological Knowledge (TK): more than just having digital skills, it involves mastering the technology to process information, communicating, and solving problems

However, although these three types of knowledge are essential when creating activities through digital media, they are not enough. When they interact, these three components are modified, producing new types of knowledge:

1. Pedagogical Content Knowledge (PCK): the transformation that the content undergoes when the teacher interprets the contents and finds multiple ways to represent them. This is the basic core of teaching.
2. Technological Content Knowledge (TCK): involves understanding the impact of technologies in the development of the disciplines being taught, since what is known about the contents changes, in part, due to the development of technologies.

[3] Koehler, M. & Mishra, P. (2009). What is Technological Pedagogical Content Knowledge (TPACK)?. *Contemporary Issues in Technology and Teacher Education, 9*(1), 60-70. Waynesville, NC USA: Society for Information Technology & Teacher Education. Retrieved March 30, 2024 from https://www.learntechlib.org/primary/p/29544/.

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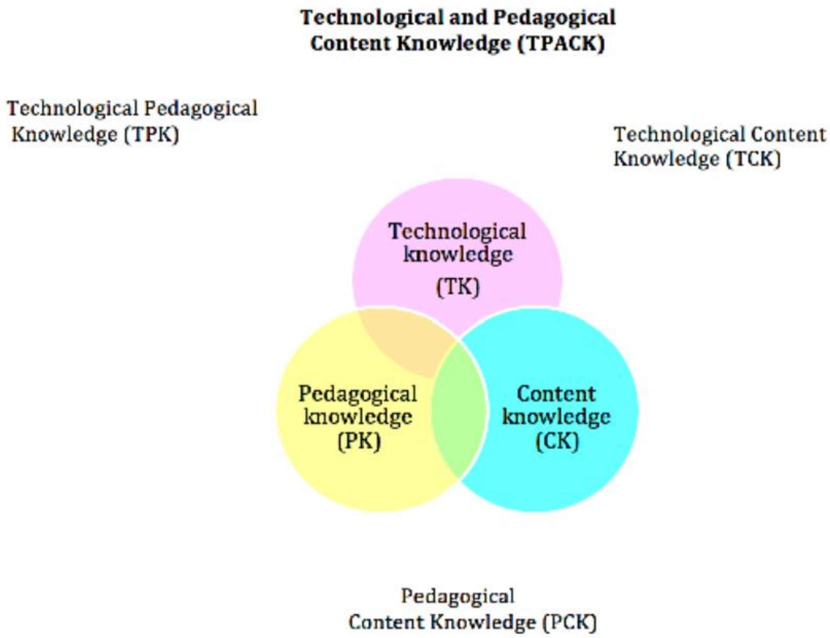
3. Technological Pedagogical Knowledge (TPK): the knowledge that allows us to understand how teaching can change when a technology is used in a given way. This type of knowledge is very important, especially since digital technologies were not initially created for educational purposes but have been adopted and adapted[4].



Source: Koehler & Mishra (2009).

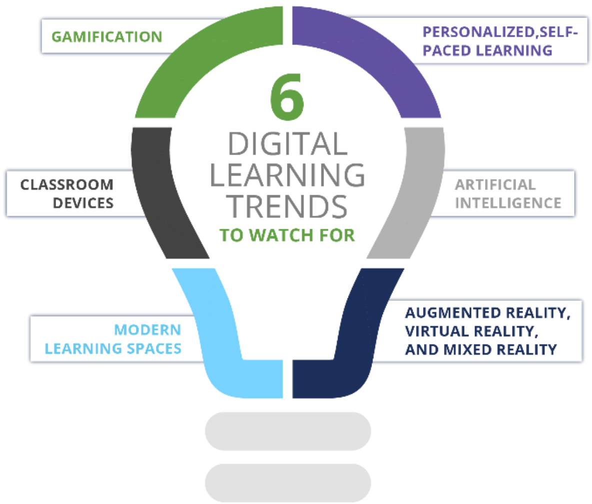
1.1. What's digital learning

Digital learning encompasses any form of education facilitated by technology. It entails engaging in the teaching and learning process through digital mediums, primarily utilizing the Internet. This can manifest in various formats such as blogs, videos, real-time lessons, seminars, or audio files.

Utilizing at least one technological device like a computer, laptop, or mobile phone, digital learning is often intertwined with distance learning, catering to individuals studying remotely from traditional educational institutions. It offers students the flexibility to progress at their own pace and choose the location of their learning, particularly

[4] The design of digital teaching resources: theoretical criteria for their development and implementation, Verónica Pérez-Serrano Flores, Dialogos sobre education, 2021, https://doi.org/10.32870/dse.vi22.918

advantageous for distance learners. Additionally, it allows students the freedom to select specific components of a course or training program they wish to focus on.



Since the advent of technology in the 1980s, its potential in enhancing educational practices has been a subject of exploration. Research has delved into leveraging digital resources for teaching purposes, exemplified by the integration of videos and computer-based resources in classrooms. Today, with the proliferation of electronic devices such as computers, smartphones, and tablets, digital educational materials continue to expand, resulting in increased technology integration in classrooms[5]. Nonetheless, educators and researchers persist in unraveling the impact of these resources on student learning.

As the market trend gravitates towards utilizing digital materials in classrooms, the development of internal and external assessment strategies becomes imperative to support students' learning journeys. However, the abundance of digital resources makes it challenging to evaluate their efficacy, posing a weakness within the educational system. Efforts to navigate this challenge remain ongoing within the educational community.

1.1.1. Benefits of digital learning

Digital learning offers numerous advantages, which we'll outline below:

- *Accessibility*: It provides individuals with the opportunity to access educational content from anywhere, eliminating the need to be physically present or enroll in a full course at a specific location.
- *Convenience*: With digital learning predominantly conducted using computers, laptops, and phones, it offers flexibility and convenience.
- *Intellectual Stimulation*: Technologies encourage the development of critical thinking skills, problem-solving abilities, learning how to learn, and fostering creativity.

[5] Mateos, M. J., Muñoz-Merino, P. J., Kloos, C. D., Hernández-Leo, D., and Redondo-Martínez, D. (2016). "Design and evaluation of a computer-based game for education," in *Proceedings of the IEEE Frontiers in Education Conference*, (Piscataway, NJ: IEEE), 1–8.

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- *Increased Interest and Motivation*: Activities facilitated through new technologies inherently generate higher levels of interest and motivation compared to traditional approaches. Studies indicate enhanced concentration and attention levels as well.
- *Enhanced Relationship with Knowledge*: Digital learning fosters a deeper exploration of information, promoting connections between various elements of knowledge and facilitating information retrieval.
- *Educational Platforms and Apps*: These tools are invaluable resources for both educators and students, providing easily accessible information and customizable learning methods for both individual and group work.
- *Real-time Updates*: Digital learning keeps students informed and engaged with the world outside the classroom through innovative and timely communication channels.
- *Adaptability*: Technological tools are designed to cater to diverse educational needs and varying levels of student preparation. They offer a range of methodologies to suit different learning contexts and individual characteristics, thereby accommodating various learning styles and even catering to students with special needs.
- The personalisation of education is one of the major potentials of digitalisation. Personalisation does not imply or assume that education is no longer social and collective; it simply refers to the delivery of education that helps learners individually in their educational journey (OECD Digital Education Outlook 2021)

1.1.2. Downsides of digital learning

The primary drawback of digital learning is the existence of the digital divide. This term refers to the discrepancy between those who have access to the internet and digital devices and those who do not. For individuals lacking access to an internet connection, computer, or mobile phone, digital learning is simply not an option.

While it is possible to purchase software containing learning materials or receive a hard drive with digital learning files, accessing files remotely on servers typically requires an internet connection. Although many areas boast extensive fiber networks, not all locations are equally equipped. Rural areas may only have access to slower networks, and regulations may restrict cable installation in densely populated areas.

Moreover, digital learning necessitates the use of a digital device, which may not be feasible for some families. Limited access to shared desktop computers or a complete absence of computers is common, and the expense of an internet connection may be prohibitive. Additionally, acquiring software for word processing or spreadsheet tasks can be costly, although some companies offer free browser-based alternatives.

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In the educational context, several further concerns arise:

- Excessive reliance on technology may diminish the effectiveness of teachers, who may become less proactive in addressing class issues or feel less motivated to intervene personally.
- The abundance of computers, tablets, and interactive programs can be distracting for students, potentially hindering their focus and productivity.
- Disparities in access to technology beyond the classroom persist, placing some individuals at a disadvantage compared to peers who regularly engage with various devices.
- Accessing apps and platforms may entail sharing sensitive data, raising concerns about online safety, particularly for minors.
- equipping teachers and learners with sufficient digital skills and competences can be costly and time-taking (CEDEFOP, Digital inclusion and wellbeing, page 2);
- learners with special educational needs may have different learning paces while using ICT tools and are at greater risk to face difficulties during the learning process (CEDEFOP, Digital inclusion and wellbeing, page 2).

2. A theoretical framework: digital material for training and learning[6]

Numerous studies explore the correlation between learning and the enhancement of executive functions and skills through the utilization of digital tools and materials[7]. Executive functions, which mature from infancy to early adulthood, encompass cognitive abilities such as visuospatial skills, problem-solving, logical thinking, and working

[6] Assessment of the Effects of Digital Educational Material on Executive Function Performance, Natalia Lara Nieto-Márquez, Alejandro Cardeña Martínez, Alejandro Baldominos,Almudena González Petronila, Miguel Ángel Pérez Nieto, Front. Educ., 23 November 2020 Sec. Digital Education Volume 5 - 2020 | https://doi.org/10.3389/feduc.2020.545709

[7] Santiago, K., Lukas, J. F., Etxeberria, J., and Gobantes, A. (2009). Evaluation of the IKASYS programme. Research, Reflections and Innovations in Integrating ICT in Education. Badajoz: FORMATEX, 51–54. Blumberg, F. C., and Fisch, S. M. (2013). "Introduction: digital games as a context for cognitive development, learning, and developmental research," in Digital Games: A Context for Cognitive Development. New Directions for Child and Adolescent Development, eds F. C. Blumberg and S. M. Fisch (Hoboken, NJ: John Wiley & Sons), 1–9. Oei, A. C., and Patterson, M. D. (2013). Enhancing cognition with video games: a multiple game training study. PLoS One 8:e0058546. doi: 10.1371/journal.pone.0058546

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memory. Research suggests that technology usage may contribute to the development of these cognitive skills and facilitate learning.

Some studies indicate improvements in reasoning, speed training in reasoning, and working memory among school-aged children through the utilization of digital materials. Such research underscores the potential for these studies to foster the development of students' skills, enhance their instruction, and facilitate knowledge transfer. Additionally, studies suggest that digital materials incorporating game or video game elements can serve as effective tools for cognitive skills training[8].

Many applications available today offer opportunities for training and improving executive functions, with the potential to transfer acquired skills to other tasks[9]. However, for optimal efficacy, the design and instructions of digital materials, including games, videos, and activities, must align with students' cognitive and emotional development needs. Moreover, these educational resources should adhere to a pedagogical foundation established by experts knowledgeable about students' needs and skills. This ensures that the learning process is shaped effectively and stimulates beneficial behavioral changes.

2.1. Digital tools for training and learning

Digital tools encompass a broad spectrum of technology and software designed to facilitate teaching and learning endeavors. These tools span from basic applications such as word processors and presentation software to more sophisticated platforms like learning management systems, virtual reality simulations, and artificial intelligence applications.

An exemplary illustration of the transformative impact of digital tools on learning is Google Classroom. This free web service, developed by Google specifically for educational institutions, streamlines the process of creating, distributing, and assessing assignments in a paperless format. Google Classroom empowers educators to effortlessly manage classes, share announcements and assignments, and provide feedback to students within a unified platform. Students, in turn, gain access to course materials, complete assignments, collaborate with peers, and communicate with teachers, all through this

[8] Homer, B. D., Plass, J. L., Raffaele, C., Ober, T. M., and Ali, A. (2018). Improving high school students' executive functions through digital game play. Comput. Educ. 117, 50–58. doi: 10.1016/j.compedu.2017.09.011

[9] Oei, A. C., and Patterson, M. D. (2013). Enhancing cognition with video games: a multiple game training study. PLoS One 8:e0058546. doi: 10.1371/journal.pone.0058546

Hirsh-Pasek, K., Zosh, J. M., Golinkoff, R. M., Gray, J. H., Robb, M. B., and Kaufman, J. (2015). Putting education in "educational" apps: lessons from the science of learning. Psychol. Sci. Public Interest 16, 3–34. doi: 10.1177/1529100615569721 centralized interface. Moreover, Google Classroom seamlessly integrates with other Google tools such as Drive, Docs, and Slides, facilitating seamless collaboration and submission of assignments.

Another noteworthy application of digital tools is the utilization of interactive educational games. These games offer an engaging and entertaining approach to learning and reinforcing fundamental concepts. For instance, titles like "Math Blaster" and "Reader Rabbit" effectively impart math and reading skills in an enjoyable manner. Similarly, language learning apps like Duolingo and Babbel leverage interactive features such as speech recognition and personalized feedback to facilitate language acquisition.

The advantages of employing digital tools in learning are manifold. Firstly, they broaden access to information and resources beyond the confines of traditional classrooms. Through online courses and educational games, students can glean insights from subject matter experts and hone skills tailored to their individual learning requirements. Additionally, digital tools afford flexibility, enabling students to learn at their own pace and convenience, a boon for those with hectic schedules or requiring additional time to grasp complex concepts.

Moreover, digital tools foster collaboration and communication, exemplified by initiatives like V.I.R.Tu.A.L. project. Online forums and collaborative projects facilitate interaction among students, fostering teamwork and communication skills vital for success in future professional endeavors. Overall, digital tools not only enhance the learning experience but also equip students with essential competencies for the evolving landscape of the modern workforce.

Numerous digital tools exist to augment teaching and learning experiences in the classroom. Here are several examples:

- **Learning Management Systems (LMS)**: Platforms like Moodle, Blackboard, or Canvas furnish online spaces where educators can upload course materials, assignments, quizzes, and grades, accessible to students from any location.
- **Interactive Whiteboards**: These digital boards facilitate the display and manipulation of digital content, annotation of presentations, and playback of videos or animations.
- **Classroom Response Systems**: Also known as clickers or polling systems, these tools enable teachers to pose questions and receive real-time feedback from students using mobile devices or dedicated hardware.
- **Digital Textbooks and E-books**: Accessible from anywhere, these resources feature interactive elements such as videos, animations, and quizzes.

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- **Collaborative Tools**: Platforms like Google Drive, Microsoft Teams, or Slack facilitate collaborative work on documents, projects, and presentations among students and teachers.
- **Virtual Labs and Simulations**: These tools generate realistic and immersive simulations of scientific experiments, historical events, or other scenarios for students to explore and learn from.
- **Augmented and Virtual Reality (AR/VR)**: AR and VR technologies deliver immersive and interactive learning experiences, such as bringing historical or scientific objects to life or enabling virtual exploration of inaccessible locations.

Additionally, it's noteworthy that the landscape of online teaching tools continues to expand, encompassing three main categories: online classrooms, assistive technologies, and applications (apps). This list is by no means exhaustive, highlighting the wide array of resources available to educators and learners for enriching educational experiences.

In recent years, both students and educators have increasingly embraced the concept of online classrooms, integrating their teaching and learning materials into virtual learning platforms or learning management systems (LMS). These online classrooms serve as virtual repositories housing textbooks, materials, resources, and notes, among other assets. Within these platforms, one may encounter various types of online classrooms, each catering to different learning needs:

- **Blended Classrooms**: These classrooms combine traditional face-to-face instruction with online student-facilitated learning, leveraging the tools and resources provided by teachers for student use.
- **Flipped Classrooms**: In a flipped classroom model, students are tasked with engaging in online Free work prior to attending physical classroom sessions. Class time is then devoted to hands-on projects and activities, assuming students have already acquired the necessary online content knowledge.
- **Distance Education Classes**: Also known as virtual schools, distance education classes deliver instruction exclusively via the internet and teacher-provided online tools, with no physical interaction between teachers and students.

Additionally, assistive technology plays a crucial role in enhancing the learning experience for individuals with disabilities, aiming to address challenges related to speech, writing, reading, hearing, arithmetic, and other areas. **Assistive technology** (AT) encompasses a range of tools and resources, including text-to-speech software, word prediction tools, electronic math worksheets, and talking calculators, among others.

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Moreover, **applications**, commonly known as apps, offer diverse avenues for supporting student learning. However, it's imperative for educators to adopt a strategic approach when selecting which apps to incorporate into their classroom activities. Some popular examples of educational apps include Nearpod (an interactive presentation tool), Quizlet (an online study tool), Remind (a parent communication tool), EdPuzzle (a video creation tool), and Formative (an assessment tool), among countless others. The abundance of available apps underscores the wealth of possibilities for leveraging technology to enhance teaching and learning experiences.

2.1.1. Digital material design and developing[10]

The creation of digital educational materials encompasses various disciplines, making it an interdisciplinary field. Within this realm, one can draw upon guides or theories from psychology or pedagogy to develop these materials. These disciplines offer diverse pedagogical models that can be adapted or structured to design and develop digital materials, elucidating how students benefit from digital activities. Some educational theories applicable to digital material include the Cognitive Theory of Multimedia Learning, which focuses on how information is processed for learning through different channels, based on cognitive sciences[11]. Other theories and pedagogical models revolve around cognitivism, behaviorism, and constructivism[12]. Additionally, there are models rooted in theories of intelligence[13] that link different multiple intelligences with the use of technology.

The design and implementation of didactic resources should prioritize pedagogy over technology. This entails explaining not only the purposes of the medium and its usage instructions but also providing concrete pedagogical guidance on how to utilize it effectively for teaching and learning purposes.

[10] Assessment of the Effects of Digital Educational Material on Executive Function Performance, Natalia Lara Nieto-Márquez, Alejandro Cardeña Martínez, Alejandro Baldominos,Almudena González Petronila, Miguel Ángel Pérez Nieto, Front. Educ., 23 November 2020 Sec. Digital Education Volume 5 - 2020 | https://doi.org/10.3389/feduc.2020.545709
[11] Mayer, R. E. (2005). Cognitive theory of multimedia learning. Camb. Handb. Multimedia Learn. 41, 31–48.
[12] Bellotti, F., Ott, M., Arnab, S., Berta, R., de Freitas, S., Kiili, K., et al. (2011). "Designing serious games for education: from pedagogical principles to game mechanisms," in Proceedings of the 5th European Conference on Games Based Learning, (Greece: University of Athens), 26–34.
Mateos, M. J., Muñoz-Merino, P. J., Kloos, C. D., Hernández-Leo, D., and Redondo-Martínez, D. (2016). "Design and evaluation of a computer-based game for education," in Poceedings of the IEEE Frontiers in Education Conference, (Piscataway, NJ: IEEE), 1–8.
[13] Gardner, H. (1983). Multiple Intelligences. New York, NY: Basic Books.

It is essential that users of digital mediums understand not just the mechanics of their operation but also their underlying pedagogical principles. This requirement poses a challenge for professionals (such as teachers and administrators) and even more so for students and parents. Hence, careful and transparent design is crucial for digital training aimed at these stakeholders.

Regarding pedagogical considerations, it is advisable to incorporate details on the types of activities and the time students will spend engaging with them. A hypothesis of digital instructional activities' categorization is the following[14]:

1. Assimilation activities (reading, listening, watching; e.g., accessing information on a website, listening to a podcast, or viewing a YouTube video).
2. Information manipulation activities (e.g., utilizing statistical analysis software like SPSS or Excel).
3. Communication and productive activities (creating a multimedia presentation or similar artifacts).
4. Experiential activities (practicing or imitating a skill, such as through a strategy video game).
5. Adaptive activities (modeling or simulating, e.g., employing a virtual reality simulator).

In addition to meeting pedagogical requirements, it's essential to complement these approaches with expertise from other fields, such as developers, human-computer interaction (HCI), user experience (UX), user experience research (UXR), cognitive ergonomics, and information technology (IT). These interdisciplinary approaches emphasize the importance of analyzing and exploring user interactions with digital materials based on their actions and decisions. The diversity of interactions and feedback across various devices (computers, tablets, or smartphones) has the potential to enhance learning if the design remains consistent. Consequently, several guides[15] have been developed to align the different tasks involved in creating digital material with pedagogical models, aiming to achieve a balance across different fields.

Furthermore, regulatory bodies or Research Centers establish standards/Guidelines for the development of high-quality digital material. Some examples are:

[14] Conole, G. (2013). Tools and resourses to guide practice. In Beetham, H.; R. Sharpe (eds.). Rethink Pedagogy for a Digital Age. New York: Routledge, 120-150.
[15] Lopez-Rosenfeld, M., Goldin, A. P., Lipina, S., Sigman, M., and Slezak, D. F. (2013). Mate Marote: a flexible automated framework for large-scale educational interventions. Comput. Educ. 68, 307–313. doi: 10.1016/j.compedu.2013.05.018

- in Spain, with the **UNE 71362:2017 standard**[16].The purpose of this standard is to provide a model and tool for evaluating the quality of digital educational materials (DEM) created and used in electronic teaching and learning environments. At the same time, the ultimate goals are to facilitate and promote the creation, improvement, evaluation and manual, semi-automatic or automatic selection of DEM that are effective in their didactic and technological use. The standard is aimed at any person, group, institution, administration or company involved in the processes of creation, use and evaluation of digital educational material.

- in Norwegian, the Norwegian Centre for ICT in Education. This guideline ("**Quality Criteria for Digital Learning Resources**"[17]) starts from the consideration that many general quality areas pertain to all learning resources, regardless of whether or not they are digital. Elements such as structure, language, use of illustrations and the type and scope of the learning assignments are important, independent of whether the resources are offered in a printed or digital form. The same applies to being aware of gender patterns, discrimination, objectivity, and representativeness. The Guideline reports the evaluation criteria organized in three broad categories: *User dimension*: the interface between user and resource; *Distinctiveness of the digital resource*: the possibilities and limitations of the digital resource; *Subject and education dimension*: the educational and evaluation potential. The Guideline underlines and elaborates also **technical aspects** about digital resources, regarding ***Accessibility, Metadata tagging and Technical interoperability.***
- "**ISO Digital Learning Solutions Toolkit**"[18]. Realized by the ISO Central Secretariat who built the DLS Toolkit to support ISO members in developing and implementing their own specific digital learning solution (DLS) strategy that should be tailored to meet their specific needs. An DLS strategy should set out the vision, goals and plan for an organization to proceed with developing its digital learning solutions to meet the needs of the business and end users. It should focus on getting the right content to the right user at the right time through strategic planning of content creation, delivery and resources management. Toolkit requires particular attention to the following outcomes in terms of: *Learning agility*, to enhance the resilience of learning capabilities and improve the achievement of learning outcomes by providing a blend of digitally enhanced delivery formats and time flexibility; *Learning proficiency*, to improve the effectiveness and efficiency of knowledge transfer and application through better use of digital technology,

[16] AENOR (2017). Norma UNE 71362:2017, De 14 De Junio De 2017. Calidad de Los Materiales Educativos Digitales [Digital Didactic Material Quality]. Madrid: Asociación Española de Normalización y Certificación (AENOR).
[17] https://www.udir.no/globalassets/filer/tall-og-forskning/rapporter/2012/quality_criteria_dlr-eng.pdf
[18] https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100462_Level3.pdf

microlearning and content curation; *Learning accessibility*, to maximize the number of learners who have access to knowledge acquisition by optimizing the delivery method for the availability of digital technology, level of targeted skills and complexity of content

The **International Society for Technology in Education** (ISTE) has outlined a set of fundamental conditions necessary for the successful integration of technology into education. ISTE has identified 14 essential conditions for technology integration[19]:

- *Shared Vision*: Proactive leadership is required to develop a unified vision for educational technology among all stakeholders, including teachers, support staff, school and district administrators, teacher educators, students, parents, and the community.
- *Empowered Leaders*: Stakeholders at all levels must be empowered to lead change.
- *Implementation Planning*: A systematic plan is needed to align technology with school effectiveness and student learning goals through the incorporation of information and communication technology (ICT) and digital learning resources.
- *Consistent and Adequate Funding*: Ongoing funding is necessary to support technology infrastructure, personnel, digital resources, and staff development.
- *Equitable Access*: Robust and reliable connectivity and access to current and emerging technologies and digital resources should be available to all students, including those with special needs, as well as teachers, staff, and school leaders.
- *Skilled Personnel*: Educators, support staff, and leaders need to possess the skills required to select and effectively utilize appropriate ICT resources.
- *Ongoing Professional Learning*: Technology-related professional learning plans and opportunities, with dedicated time for practice and idea-sharing, are essential.
- *Technical Support*: Consistent and reliable assistance is needed for maintaining, renewing, and utilizing ICT and digital learning resources.
- *Curriculum Framework*: Content standards and related digital curriculum resources should align with and support digital-age learning and work.
- *Student-Centered Learning*: Planning, teaching, and assessment should revolve around the needs and abilities of students.
- *Assessment and Evaluation*: Continuous assessment of teaching, learning, and leadership, along with evaluation of the use of IT and digital resources, is crucial.
- *Engaged Communities*: Partnerships and collaboration within communities are necessary to support and fund the use of ICT and digital learning resources.

[19] http://www.iste.org/standards/essential-conditions

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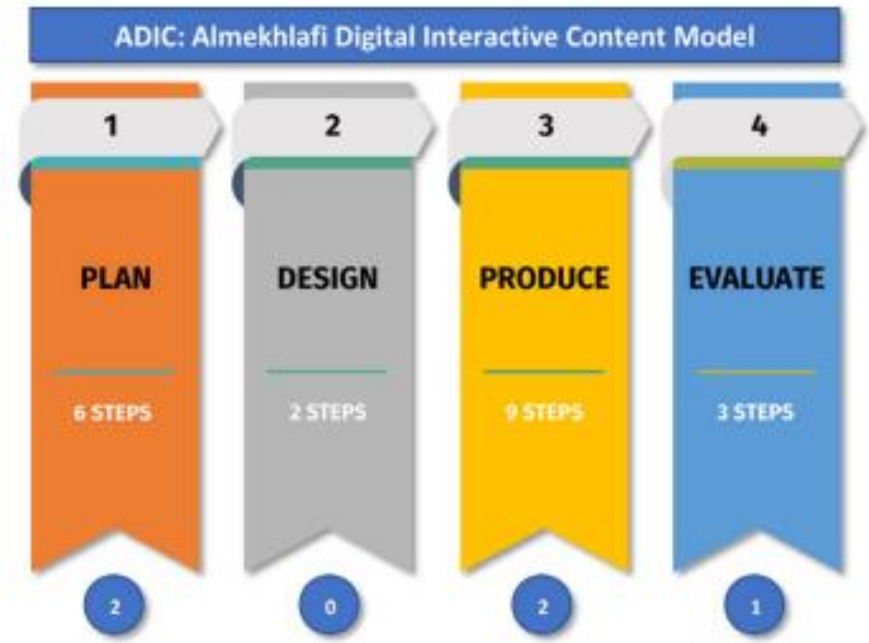
- *Support Policies*: Policies, financial plans, accountability measures, and incentive structures should support the use of IT and other digital resources for learning and district/school operations.
- *Supportive External Context*: Policies and initiatives at the national, regional, and local levels should support schools and teacher preparation programs in effectively implementing technology to achieve curriculum and learning technology standards.

After the premises above, it's important to consider that there are different and numerous models that have defined the approaches to digital material implementation.

The most widely used model is that proposed by Dick and Carey[20], and the successive approximation model (SAM) is the most recent. Other well-known models include ADDIE, ARCS, ASSURE, four-component instructional design (4C-ID), and backward design models. All these models have been used for different contexts and purposes to develop instructional content.

VIRTUAL project refers to Almekhlafi's model (ADIC)[21] for digital interactive content design and development, that's considered as a guide that can be used in the production of interactive content for any subject. It is also considered as a framework for developing content. The model consists of four main stages: planning, design, production and evaluation.

[20] Dick, W. (1996). The Dick and Carey Model: Will It Survive the Decade? Educational Technology Research and Development, 44, (3), 55–63. DOI https://doi.org/10.1007/ BF02300425
[21] ADIC: Hands-on Guide for Designing and Developing Digital Interactive Content, Dr. Abdurrahman Ghaleb Almekhlafi United Arab Emirates University



Source: *ADIC: Hands-on Guide for Designing and Developing Digital Interactive Content*

2.1.2. Digital material design

Following the ADIC Model, before design some steps must be accomplished in the planning step. We mention some of these steps, that we think are adherent to VIRTUAL project "opinion" and "context". In particular:

- Verification of standards in the field of content, e.g. if the public governance of curriculum foreseen specific rules for digital materials
- Study of learners' characteristics and needs. According to researchers, designers need to do an analysis of their audience to know several characteristics such as demographic information, prior knowledge of the topic, and anxiety level. In addition, designers need to identify the ethical issues involved in the delivery processes such as equal opportunity, cultural diversity, and accessibility
- Selection of the platform to be used to develop the interactive content. This platform could be a multimedia authoring software, mobile application, eLearning management system, or internet services

About **design phase**:

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- The first step involves preparing an **outline of the project**, using concept mapping, content outline, flowcharting, and finally ending with storyboards
- The second step in the design phase is **screen design**. In this step, the developer must consider a number of issues related to screen design, such as the compatibility of the developed product with different devices. In addition, a navigation system should be designed to make it easier to use and navigate the product. The are different principles of design that can be taken into consideration when designing digital materials (simplicity, harmony, sequence, balance, alignment, repetition, proximity, contrast, prediction).

2.1.3. Digital material production

The **production phase** consists of 9 steps, according to ADIC model. It might be worth noting that these steps should not be followed in a sequence.

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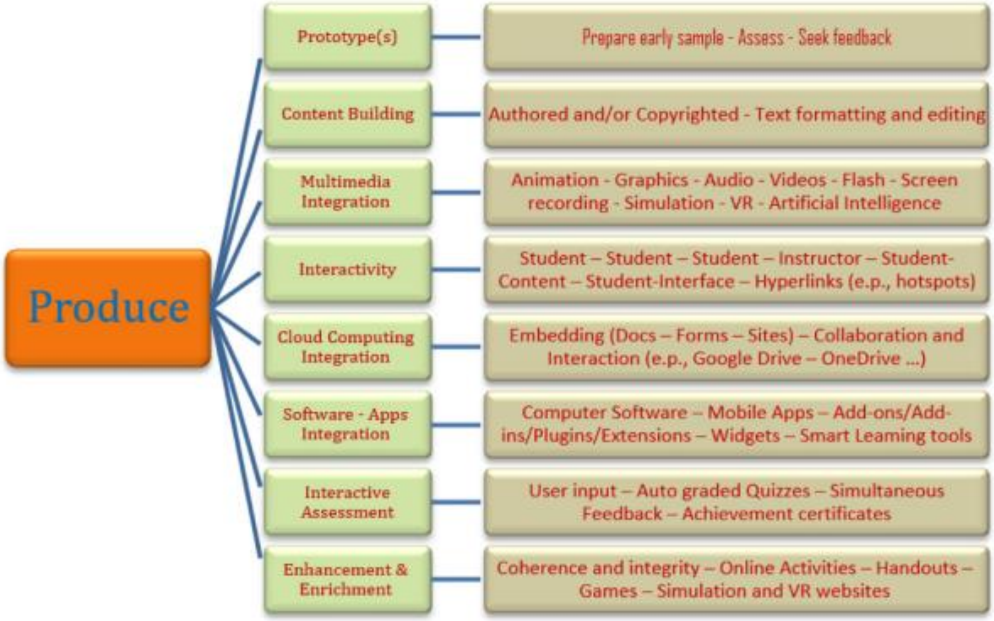
Representation of ADIC Production Phase.



Source: *ADIC: Hands-on Guide for Designing and Developing Digital Interactive Content*

- Prototyping: The initial phase involves constructing a sample version of the project and gathering feedback from users. If the feedback received is positive, the project proceeds with the same design. However, if users provide observations in their feedback, revisions to the project should be made accordingly.
- Content Development: The developer is tasked with adding content either independently or by sourcing it from various channels while ensuring the retention of copyright. Once the content is integrated into the project, attention should shift towards editing, formatting, and considering the design. Other phases, such as selecting the design team and the team responsible for creating and implementing e-content, occur between material selection and production.
- Multimedia Integration: Multimedia plays a pivotal role in crafting interactive digital content, irrespective of its intended application or context. Therefore, after content development, the developer should commence integrating multimedia elements into the project. Any multimedia elements incorporated, such as animations, graphics, videos, and simulations, should be feasible and contribute to achieving project objectives.

- Software and App Integration: Similar to cloud computing, integrating diverse software types, apps, plug-ins, and widgets can significantly enhance the project, rendering it more interactive and captivating. Certain software and apps can breathe life into the project, enriching its content and immersing the audience, thereby fostering engagement and learning.
- Cloud Computing Integration: Integrating cloud computing services into digital interactive content is crucial for rendering the project interactive, appealing to the audience, and content-rich. Cloud computing services encompass various file integrations, including PDFs, images, videos, handouts, quizzes, and online collaboration activities.
- Interactivity: Given the aim to attract and engage the target audience, emphasis should be placed on interaction. This interaction should encompass one or more of the four well-known types: student-student, student-instructor, student-interface, and student-content interaction. Various strategies and techniques, such as hyperlinks, hotspot hyperlinks, and navigation menus, facilitate effective interaction.
- Interactive Assessment: Interactive assessment stands as a significant component of educational content. As the goal is to create interactive content, assessments must also possess interactivity, accompanied by simultaneous user feedback. Developers can achieve this through techniques such as test makers, quiz applications, and internet services.
- Enhancement and Enrichment: The final step in the production phase involves enhancing and enriching the product. Developers should augment the project using online handouts, games, virtual reality, and simulation platforms.

3. Learning with virtual reality (VR) and augmented reality (AR)

VR AND AR REALITY

Augmented Reality (AR) involves enriching the physical world with virtual information, creating an enhanced environment for users

Virtual reality (VR) is a technology that transports users into immersive virtual worlds, allowing them to interact as if they were in the physical realm

3.1. First definitions

Augmented Reality (AR) involves enriching the physical world with virtual information, creating an enhanced environment for users. This technology overlays computer-generated 3D objects onto the real world, allowing interaction via mobile device screens. Whether experienced directly or through devices like cameras, AR supplements real-world visuals with computer-generated input. It seamlessly integrates virtual and real elements, generating 3D objects displayed on screens. AR finds applications across various fields, including education, where it serves as an engaging learning tool. Educational AR content requires devices with adequate specifications, such as smartphones, and typically includes 3D animations/images and integrated camera functionality. AR learning materials facilitate the visualization of abstract concepts, aiding comprehension and providing a more effective learning experience aligned with educational objectives.

Virtual reality (VR) is a technology that transports users into immersive virtual worlds, allowing them to interact as if they were in the physical realm. VR relies on computer-based systems equipped with specialized input and output devices, enabling direct engagement with virtual environments. Learning materials constructed with VR offer students the opportunity for anytime, enjoyable learning experiences, unrestricted by spatial or temporal constraints. VR can replicate sensory experiences, primarily relying on visual stimuli to create virtual environments. VR applications enable users to engage with reality in altered

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ways, modifying sensory perceptions such as sight and sound. Standard VR systems typically utilize headsets or multiprojection setups to deliver realistic visuals, audio, and other sensations, simulating the user's presence within the virtual environment. Through the use of VR devices, users can achieve high levels of immersion, experiencing virtual environments that envelop them, fostering a sense of being fully integrated into the virtual world.

In contrast, Augmented Reality (AR) enhances the user's real-world perspective by overlaying digital information, while Virtual Reality (VR) transports the user into a completely simulated environment. Both AR and VR have educational applications, serving various purposes. VR technology enables the creation of immersive educational experiences such as virtual field trips or historical event simulations, enhancing engagement and interactivity in learning. For instance, a virtual reality tour of a historical site offers students a more vivid and lifelike experience, surpassing the limitations of traditional textbooks or lectures.

On the other hand, AR technology enhances students' comprehension of real-world objects and concepts. For example, an AR application can augment information about the human body onto a real person, enabling students to interact with and explore the body in ways not possible with traditional resources like textbooks or models.

Overall, VR technology is more immersive and can be used to create completely new educational experiences, whereas AR technology is more focused on enhancing and making the real world more interactive and informative. Both have distinct advantages and can be useful in a variety of educational settings. Table below highlights the similarities and difference of AR/VR including their applications in education.

Difference in the application and effects of VR and AR Technology in Education

Technology	Key similarities	Key differences	Applications in education
Augmented reality (AR)	• Both have distinct advantages and can be useful in a variety of educational settings (Park, 2022). • Both AR and VR may also be utilized to make interactive and gamified learning experiences for students (Chan et al., 2022) • Both can make the learning process more engaging and pleasurable (Zhang et al., 2022) • Potential to significantly improve the educational experience and make learning more interactive, immersive, and effective (Verner et al., 2022).	• Overlays digital information on the user's perspective of the actual world (Verner et al., 2022) • Focused on enhancing and making the real world more interactive and informative (Cook et al., 2021)	• Enables digital information to be superimposed on the actual environment, such as displaying text, photos, or videos on top of a real-world item Can be used to improve students' understanding of real-world objects and concepts (Solmaz et al., 2021). • Utilized in areas such as history, science, and art to give students with more context and knowledge. • Example: Overlay information about the human body on a real person, allowing students to see and interact with the body in ways that a traditional textbook or model would not allow (Morimoto et al., 2022). This provide students with a more vivid and realistic understanding of what it was like to be there than a traditional textbook or lecture (Bansal et al., 2022).
Visual Reality (VR)		• VR creates completely new educational experiences (Zhang et al., 2022). • Immerses the user in a wholly fake environment (Chan et al., 2022)	• Virtual field excursions or simulations of historical events may be created (Chan et al., 2022) • Example: Used to imitate real-life experiences that would be difficult or impossible to experience in person, such as visiting a distant nation or researching the human body (Bansal et al., 2022)

Source: Leading Virtual Reality (VR) and Augmented Reality (AR) in Education: Bibliometric and Content Analysis from the Web of Science (2018–2022) Xiaoli Zhao, Yu Ren, and Kenny S. L. Cheah

Augmented Reality (AR) and Virtual Reality (VR) technologies have the potential to revolutionize the world of education and provide a more immersive and engaging learning experience for students. Through the use of these technologies, students can be immersed in a variety of different visuals, audio cues, and simulations, which can help to increase their interest in the subject matter. Additionally, these technologies can also be used to create more engaging virtual worlds, which can provide a more engaging and interesting learning experience. Some of the practical implications could be as follows:

- AR and VR technologies can be used to provide a more immersive and interactive learning experience. By using these technologies, students can be exposed to a variety of engaging visuals and audio cues, which can help to increase their interest in the subject matter. Moreover, these technologies can also be used to create more engaging simulations and virtual worlds, which can provide a more engaging and interesting learning experience.

- AR and VR technologies can be used to increase the relevance of the content being taught. By allowing students to explore different environments and interact with content in a more realistic way, these technologies can provide a better understanding of the content being taught. In addition, these technologies can also be used to introduce new concepts and ideas in a more engaging way, which can help to increase student engagement and enthusiasm.

- AR and VR technologies can provide a more accessible learning experience for students with special needs. By allowing students to explore virtual environments at their own pace and on their own terms, these technologies can make learning more accessible for those with physical or cognitive impairments.

Although Augmented Reality (AR) and Virtual Reality (VR) are powerful tools for enhancing education, they also come with some limitations. One of the main challenges with AR and VR is the high cost of the hardware, which can make it difficult for schools and universities to implement the technology. Another limitation of AR and VR is their complexity. Since these technologies are relatively new, it can be difficult for teachers and students to use them without any prior knowledge or experience. It can also be difficult to ensure the software and hardware are properly set up and maintained, and this can lead to technical issues and disruptions during classes. In addition, some of the immersive experiences created by AR and VR can be distracting for students, making it difficult for them to focus and retain information. There are still some limitations to the research on these technologies:

- The cost of implementing AR and VR technologies in a classroom environment can be prohibitively high, creating a barrier for some schools and institutions. Additionally, many schools and teachers may lack the technical knowledge to effectively implement these technologies in the classroom.
- There is also a lack of proper evaluation criteria for research on AR and VR in education. This can make it difficult to compare the effectiveness of different implementations, and make it challenging to accurately assess the benefits of these technologies.

The future direction of augmented and virtual reality (AR/VR) is poised for significant growth as the technology continues to become more advanced and accessible. With advancements in hardware such as wearable devices, head-mounted displays, and haptic technologies combined with improvements in software development tools including AI and machine learning algorithms, AR/VR has the potential to revolutionize the way people interact with digital content. Furthermore, the rise of 5G and 6G networks will enable faster processing speeds resulting in enhanced user experiences with reduced latency. As AR/VR becomes more mainstream across a broader range of industries worldwide; this trend is expected to continue into 2030 and beyond.

Furthermore, Augmented and virtual reality technologies allow educators to recreate real-life scenarios, employ immersive learning environments, and provide students with hands-on experiences that bridge the gap between theory and practice. With the continuous developments in these technologies, it is expected that they will fully transform the way we teach and learn. As such, schools are encouraged to invest more time, resources, and training towards implementing these technologies within their curriculum. Augmented reality can bring textbooks to life with interactive diagrams while virtual reality can create immersive simulations that enable students to experience real-world scenarios in a safe environment. These advancements aim to address the limitations of traditional classroom setups while also enhancing engagement levels amongst learners.

3.2. Benefits of Augmented and Virtual Reality in Education

Over the last two decades, extensive research has highlighted the advantages of integrating virtual and augmented reality into educational settings. One of the most significant benefits is the transformation of the teacher's role from a mere transmitter of knowledge to a facilitator who guides students in exploration and learning. This shift aligns well with the constructivist learning theory, as students feel empowered and engaged, taking control of their learning process. In virtual environments, students can learn experientially and progress at their own pace, avoiding scenarios where some students lag behind during lectures.

Moreover, virtual reality aids in comprehending abstract concepts by enabling students to experience and visualize them within a virtual space. Unlike traditional language-based learning, virtual reality fosters active engagement, particularly benefiting learners with low spatial ability by reducing cognitive load.

Another significant advancement is the use of AR and VR to provide customized learning experiences in which the information is tailored to the individual student’s requirements and skills. This may aid in increasing student engagement and motivation while also addressing the requirements of various student groups. For example, AR and VR technology extends learning beyond memory and observation by providing students with access to realistic information that aids in the comprehension of complex topics. Furthermore, VR offers a more immersive learning experience, allowing educators to scale their curriculum to make learning more enjoyable.

Virtual reality facilitates understanding of systems and objects across varying scales. For instance, applications like the charcoal mini-blast furnace allow students to explore both the overall system and its individual components seamlessly. Similarly, studying human anatomy in virtual reality provides a better understanding of organ sizes and their spatial relationships, aiding memory retention.

Furthermore, virtual reality simulations provide a safe environment for learning in high-risk or rare scenarios, such as surgical practice or machine tool operation. Students can grasp the consequences of failure without physical harm to themselves or equipment. AR and VR may be utilized to construct virtual field excursions, enabling students to explore and learn about areas that would be difficult or impossible to visit otherwise

The flexibility of virtual reality extends to testing and design, allowing for rapid prototyping and experimentation without the constraints of physical materials. It enables precise control over experimental variables and eliminates extraneous factors, enhancing the validity of tests.

Lastly, the immersive nature of virtual reality minimizes distractions, enhancing student focus and concentration on learning objectives. By transforming passive learners into active participants, virtual reality improves student motivation and sense of control over their learning.

3.3. Challenges of Augmented and Virtual Reality in Education

Despite its benefits, integrating virtual reality into education requires addressing several challenges. Historically, cost and technological barriers hindered widespread adoption, but advancements have made virtual reality more accessible.

However, technical issues, such as device malfunctions or user discomfort, remain concerns. Additionally, the learning curve for both students and teachers in using virtual reality devices necessitates time and support

Educators must also ensure that virtual reality aligns with educational objectives and curriculum requirements. Professional development opportunities can help teachers integrate virtual reality effectively into their teaching practices.

Ultimately, while virtual reality offers exciting possibilities for education, its successful implementation requires careful planning, ongoing support, and alignment with pedagogical goals.

3.4. The Primary Goals of Educators and Students in Utilizing AR and VR

Teachers incorporate VR and AR technologies to create immersive and captivating learning environments, aiming to enhance student engagement and retention of knowledge. For example, in science classes, teachers might utilize VR for virtual field trips to historical sites or AR to augment information onto real-world objects. These technologies offer hands-on learning experiences that traditional methods struggle to replicate, enabling students to grasp complex concepts more effectively. Students, in turn, can utilize VR for simulating intricate surgical procedures or AR to explore virtual representations of anatomical structures. Clearly, both educators and students seek to employ VR and AR to deliver dynamic, immersive learning experiences that enhance understanding and retention of subject matter.

Further considerations for enhancing the classroom experience include:

- Immersive Learning: VR and AR can create immersive environments where students interact with virtual simulations or 3D models of real-world concepts, fostering engagement and dynamism.
- Virtual Field Trips: These technologies enable virtual visits to locations that are challenging or impossible to access physically, enriching students' learning experiences.
- Collaborative Learning: VR and AR foster collaborative learning environments where students work together in virtual worlds to solve problems.
- Experiential Learning: By replicating real-world settings, VR and AR facilitate hands-on learning experiences that engage students actively.
- Language Learning: VR and AR can create immersive environments for language acquisition, allowing students to practice speaking and listening skills.

While the integration of VR and AR technologies promises to revolutionize education by offering dynamic learning experiences, educators face several challenges:

- Developers' Roles: Developers of VR and AR applications face multifaceted challenges ranging from conceptualization to technical implementation.
- Equipment Selection: Choosing suitable VR headsets involves considering factors such as budget, class size, teaching style, and curriculum requirements.
- Technical Compatibility: Ensuring compatibility with existing classroom infrastructure and addressing technical issues such as software and hardware compatibility are crucial.
- Setup Time: Setting up equipment, downloading apps, and preparing lessons can be time-consuming, requiring careful planning.
- Learning Difficulties: VR experiences may exacerbate learning difficulties in some individuals, necessitating careful design considerations, particularly for learners with Autism Spectrum Disorder (ASD).
- Graphics Quality: Maintaining high-quality graphics in VR experiences is essential for user immersion and authenticity in educational settings.

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Educator Upskilling: As VR and AR technologies evolve, educators must continuously upskill to effectively integrate these tools into their teaching practices.

Educators can conduct a thorough assessment of the practicality and potential integration of AR/VR technology in the classroom by considering various factors. Firstly, they should evaluate the availability of resources such as computers and high-speed internet access. Without these resources, deploying instructional technology becomes impractical.

Furthermore, educators should take into account teachers' perspectives and their assessment of STEM proficiency. Research suggests that educators need to identify challenges and barriers to implementing STEM pedagogy before integrating new technologies, especially AR/VR, into their teaching practices.

Additionally, educators can gauge students' familiarity with technology in the classroom through methods like the Muddiest Point technique. This approach involves asking students to reflect on the most challenging aspects of a lesson at its conclusion. This feedback can help teachers identify areas where students may require further support or clarification when using new technologies.

Alternatively, educational leaders should be informed about studies on the Technology Acceptance Model (TAM), which explores how teachers and students may perceive and embrace new technology positively. TAM provides insights into how students may respond to new technologies in the classroom and offers guidance on effectively introducing them.

3.5. Technological aspects to implement Augmented and Virtual training

Implementing Augmented Reality (AR) and Virtual Reality (VR) in training involves several technological aspects. Here are some key considerations.

First aspect to consider is about **software selection**. In the current landscape of virtual reality (VR) training, modeling and simulations emerge as essential components. While traditional training methods, often based on technical manuals or multimedia resources, are still widely used, their lack of immersive experience prevents them from effectively competing with VR training.

Over time, various tools have emerged. A significant example is the Virtual Reality Modeling Language (VRML), which debuted in 1994 with the aim of creating "virtual worlds" independently of headset use. After the decline of VRML, other programming languages and tools such as 3DMLW, COLLADA, O3D, and X3D emerged. Among contemporary options, game engines like Unity 3D and Unreal Engine dominate, boasting integrated APIs and software development kits (SDKs) specifically designed for VR development.

Furthermore, 3D modeling plays a crucial role in creating virtual training environments. Platforms like Unity and Unreal offer abundant 3D resources and sample projects, simplifying the content creation process even for beginners. For those seeking customization, advanced software like 3ds Max, Maya, and Blender are available. Additionally, the Virtual Reality Peripheral Network (VRPN) facilitates access to various VR system peripherals.

Important is to guarantee a design intuitive and user-friendly interfaces to enhance immersion and ease of use. Consider factors such as ergonomics, navigation, accessibility and **real-time interactivity**. This last factor is to enable real-time interactivity to allow trainees to manipulate virtual objects, practice skills, and receive immediate feedback. This could involve incorporating gesture recognition, voice commands, and haptic feedback.

Software adopted, also have to support **Data Analytics**, i.e. collect and analyze user data to assess performance, identify areas for improvement, and personalize the training experience. This could involve tracking user interactions, completion times, and performance metrics.

Another aspect to be considered is about **Procedural Generation techniques**. They are widely used in creating virtual content, including environments, models, and game levels. This method alleviates the laborious manual creation process by automating content generation based on specified parameters and scenarios. By exploring scenario-based descriptions, procedural generation frameworks can efficiently produce training scenarios. These techniques can guarantee:

- *Efficiency in Content Creation*: Procedural generation automates the process of creating virtual environments, models, and game levels based on predefined rules and parameters. This significantly reduces the time and effort required for manual content creation, allowing developers to generate vast amounts of content efficiently.
- *Scalability*: With procedural generation, training scenarios can be dynamically generated at runtime, enabling scalability to accommodate a wide range of training needs. This means that VR training applications can provide a diverse set of scenarios tailored to individual learners or specific training objectives without requiring extensive manual content creation for each scenario.
- *Customization and Adaptability*: Procedural generation allows for the creation of content that adapts to user interactions and preferences. Training scenarios can be generated on the fly based on user input or performance, providing a

personalized learning experience. This adaptability ensures that training remains engaging and relevant to the user's skill level and learning pace.

- *Variety and Realism*: Procedural generation enables the creation of diverse and realistic training scenarios by incorporating randomness and variation into content generation algorithms. This ensures that learners are exposed to a wide range of situations and challenges, enhancing the effectiveness of the training experience.
- *Cost-Effectiveness*: By automating content generation, procedural techniques help reduce the cost associated with hiring artists and developers to manually create virtual content. This makes VR training more accessible to organizations with limited budgets, allowing them to deploy immersive training solutions without significant upfront investment in content creation.
- *Consistency and Quality*: Procedural generation ensures consistency and quality in virtual content by following predefined rules and specifications. This helps maintain a high standard of content across different training scenarios, ensuring that learners receive a consistent and reliable experience regardless of the scenario they encounter.

About **hardware** we can distinguish between training using AR and VR.

The choice of hardware for augmented reality (AR) training depends on factors such as the specific requirements of the training program, budget considerations, and the level of immersion desired. Here are some hardware options commonly used for AR training:

- *Smartphones and Tablets*: Smartphones and tablets are widely accessible and can be used as AR devices through their built-in cameras and AR-enabled apps. They are suitable for basic AR training applications, such as overlaying digital information onto real-world objects or environments. Additionally, they are cost-effective and familiar to many users.
- *AR Glasses*: AR glasses, also known as smart glasses or augmented reality headsets, offer a hands-free AR experience by overlaying digital content directly into the user's field of view. Examples include Microsoft HoloLens, Magic Leap One, and Google Glass Enterprise Edition. AR glasses provide a more immersive experience than smartphones and tablets and are ideal for training scenarios that require users to move and interact in their environment while accessing AR content.
- *Smart Helmets*: Smart helmets equipped with AR technology are commonly used in industrial and enterprise settings for training purposes. These helmets typically feature a transparent visor or display that overlay digital information, such as instructions or schematics, onto the user's view of the real-world environment. They are particularly useful for hands-on training in fields such as manufacturing, maintenance, and construction.

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- *Handheld AR Devices*: Handheld AR devices, such as handheld scanners or AR viewers, can be used for training applications that involve scanning and visualizing objects or environments in 3D. These devices often feature depth-sensing cameras and high-resolution displays, allowing users to interact with digital content in a more tangible way.
- *Wearable Sensors and Trackers*: In addition to display devices, wearable sensors and trackers can be used to enhance AR training experiences by capturing and analyzing real-time data, such as motion, biometrics, and environmental conditions. These sensors can provide valuable feedback to users and trainers, enabling personalized and adaptive training scenarios.

Virtual reality (VR) training relies on immersive hardware to create realistic and engaging virtual environments for learners. The evolution of VR training is closely linked to advancements in VR devices. In the past, due to computational limitations, training activities relied on window systems, mirror systems, vehicle systems, and CAVE (Cave Automatic Virtual Environment) systems. However, the proliferation of consumer-grade VR devices has revolutionized VR training, although challenges such as motion sickness persist.

Contemporary VR devices, especially head-mounted displays (HMDs), offer unprecedented immersion, enhancing the development of cognitive, psychomotor, and affective skills. Additionally, tracking and interaction devices such as Leap Motion and Kinect sensors offer convenient and affordable solutions for motion tracking, benefiting rehabilitation and motor function recovery training. Motion capture suits, exemplified by products like PrioVR, TESLASUIT, and HoloSuit, offer precise full-body tracking and haptic feedback.

Furthermore, devices such as treadmill-based platforms simulate movement in VR environments, further enriching the immersive experience. Platforms like Cyberith Virtualizer, KAT VR, and Virtuix Omni allow users to physically navigate virtual spaces, increasing realism in VR training scenarios.

Here are some common hardware options for VR training:

- *VR Headsets*: VR headsets are the primary hardware used for immersive VR experiences. They typically consist of a head-mounted display (HMD) with built-in screens, lenses, and motion tracking sensors. There are two main types of VR headsets:
  - Tethered VR Headsets: These headsets are connected to a powerful PC or gaming console, providing high-quality graphics and performance.

Examples include the Oculus Rift, HTC Vive, and PlayStation VR. Tethered headsets are suitable for high-fidelity VR training applications that require detailed visuals and interactions.

- Standalone VR Headsets: These headsets have built-in processing capabilities, eliminating the need for a separate PC or console. Examples include the Oculus Quest and HTC Vive Focus. Standalone headsets offer greater mobility and ease of setup, making them suitable for training scenarios that require flexibility and portability.

- *Motion Controllers*: Motion controllers are handheld devices that allow users to interact with virtual environments and objects in VR. They typically feature buttons, triggers, and motion sensors for tracking hand movements and gestures. Motion controllers enable hands-on training experiences, such as manipulating objects, performing simulations, and practicing skills.
- *Room-Scale Tracking Systems*: Room-scale VR systems use external sensors or cameras to track the user's movements within a physical space, enabling them to walk around and interact with virtual environments. These systems provide a higher level of immersion and realism, especially for training scenarios that involve spatial awareness and physical movement.
- *Haptic Feedback Devices*: Haptic feedback devices provide tactile feedback to users, enhancing the sense of presence and immersion in VR. Examples include haptic gloves, vests, and controllers equipped with vibration motors or force feedback mechanisms. Haptic feedback devices can simulate sensations such as touch, texture, and impact, enriching the training experience and improving learning outcomes.
- *Eye-Tracking Technology*: Eye-tracking technology monitors the user's eye movements and gaze patterns within VR environments. This information can be used to analyze user engagement, attention, and behavior, providing valuable insights for optimizing training content and interactions. Eye-tracking technology also enables more natural and intuitive interactions, such as gaze-based selection and navigation.
- *Biometric Sensors*: Biometric sensors measure physiological signals such as heart rate, respiration, and skin conductance, allowing trainers to monitor the user's stress levels, arousal, and cognitive workload during VR training sessions. This feedback can be used to adapt training scenarios in real-time, ensuring optimal engagement and performance.

Other aspect to consider is about **integration of AR/VR training modules with Learning Management Systems (LMS)** to manage user progress, track performance, and deliver certifications. This aspect is connected with **cloud computing**, that plays a crucial role in implementing augmented and virtual reality (AR/VR) training solutions by providing scalable infrastructure, storage, and computing power. Here's a deeper look at how cloud computing supports AR/VR training:

- *Scalability*: Cloud platforms such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud offer scalable resources to handle varying workloads associated with AR/VR training. This scalability ensures that training applications can accommodate fluctuations in user demand without performance degradation.
- *Storage*: AR/VR training applications often generate and consume large amounts of data, including 3D models, textures, audio, and user interactions. Cloud storage solutions provide reliable and scalable storage for these assets, allowing easy access and management from anywhere with an internet connection.
- *Compute Power*: Rendering immersive AR/VR environments and processing complex simulations require significant computational resources. Cloud-based virtual machines (VMs) and GPU instances provide the necessary compute power to deliver high-quality training experiences without requiring expensive on-premises hardware.
- *Content Delivery*: Cloud Content Delivery Networks (CDNs) ensure low-latency delivery of AR/VR content to end-users worldwide. This is crucial for minimizing lag and providing a smooth and responsive training experience, especially for distributed teams or remote learners.
- *Collaboration and Accessibility*: Cloud-based AR/VR platforms facilitate collaboration among distributed teams by providing centralized access to training content and real-time collaboration tools. Users can access training modules from any device with internet connectivity, enabling flexible and remote learning options.
- *Cost Efficiency*: Cloud computing offers a pay-as-you-go pricing model, allowing organizations to optimize costs based on actual usage. This eliminates the need for upfront investments in hardware infrastructure and enables efficient resource utilization, ultimately reducing overall training costs.
- *Security and Compliance*: Cloud providers offer robust security features and compliance certifications to ensure the confidentiality, integrity, and availability of AR/VR training data. This includes encryption, access controls, data residency options, and compliance with industry standards and regulations.
- *Integration with Other Services*: Cloud platforms offer a wide range of services and APIs that facilitate integration with other software tools and systems. This includes integration with learning management systems (LMS), analytics platforms, authentication services, and third-party APIs for additional functionality.
- *Updates and Maintenance*: Cloud computing relieves organizations of the burden of managing hardware infrastructure and software updates. Cloud providers handle maintenance tasks such as patching, scaling, and upgrading, allowing

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organizations to focus on developing and improving their AR/VR training applications.

3.6. Augmented and Virtual Reality Educational Scenarios for VET in tourism

In order to best design training activities using AR and VR technologies, 10 cards (Educational scenario representations) have been prepared for 10 different clusters, formed through research and analysis of numerous AR/VR learning projects and also applicable to educational interventions in the tourism sector (hospitality and restaurant). The methodological approach, clusters, and glossary applied are adapted from a Guide prepared by the German Federal Institute for Vocational Education and Training (BIBB)[22], which, among other things, has adjusted Bloom's taxonomy to augmented/virtual and mixed reality training. Firstly, we start with the identification of didactic methods, which can be summarized as follows:

- *Practice and repetition*: Exercises are iterated through during training until the learner achieves mastery, such as specific hand movements with machinery or equipment.
- *Demonstration and imitation*: Trainers showcase the execution of particular professional tasks and elucidate their methodology. Learners observe, inquire, and ultimately perform the tasks themselves.
- *Task-oriented learning*: New knowledge is assimilated by learners through task completion and exercises. Typically, feedback is provided after the exercise phase. Digital tools enable instructors to offer immediate feedback, especially in interactive exercises.
- *Teaching the scientific method*: This pedagogical approach commences with presenting a "problem," such as a scientific phenomenon or technical function. Learners are tasked with defining this problem and, drawing upon their existing knowledge, autonomously crafting concepts for its resolution or explanation (forming a hypothesis), testing said hypothesis, and assessing the outcomes.
- *Circuit-based learning*: A method of structuring instruction where learners typically engage in self-directed, hands-on activities using pre-prepared materials or media set up at various stations in the learning environment.
- *Project-based learning*: Education centered around practical assignments relevant to future professional practice. Learners are tasked, either by themselves or by instructors, with a project to be completed collaboratively. This project entails a

[22] https://www.bibb.de/en/148130.php

technical challenge for which they devise potential solutions, receiving guidance but largely working independently within a defined timeframe.

- *Learning through teaching*: Students assume the role of educators to deepen their comprehension of the subject matter. This may involve delivering lectures or presentations or creating educational materials such as instructional videos.
- *Open education*: A teaching approach that empowers learners to choose the timing, location, and content of their learning. Students can opt for individual or group study and select preferred learning methods.
- *Free work*: Providing learners with significant autonomy and personal agency. It represents an extension of open education, where learners establish their own learning objectives and strive to achieve them through self-initiated efforts.
- *On-demand learning* (e.g., during daily work or in-company training): Learning occurs within the workflow as needed or deemed beneficial. Learners have access to relevant learning materials and training resources to directly address operational questions or challenges.
- *Reflective practice*: Learners engage in self-Reflective practice on their learning journey (e.g., within a learning project) by documenting their progress and/or articulating encountered obstacles. These reflective practices are shared with instructors to collaboratively determine subsequent steps.
- *Collaborative learning*: Learners form groups to independently acquire new knowledge and accomplish specific tasks. Through collaboration, learners provide feedback to one another to achieve shared learning objectives.

According to the aforementioned Guide, Bloom's taxonomy (learning objectives) "adapted" for VR/AR training can be cross-referenced with the listed didactic methods as shown in the following table.

Learning objectives	Didactic methods
Remember	Practice and repetition Demonstration and imitation Task-oriented learning
Understand	Task-oriented learning Teaching the scientific method Learning through teaching Project-based learning On-demand learning Collaborative learning
Apply	Practice and repetition Demonstration and imitation Task-oriented learning Circuit-based learning Gamification
Analyze	Teaching the scientific method

Learning objectives	Didactic methods
	Open education Free work Collaborative learning
Evaluate	Teaching the scientific method Open education Project-based learning Reflective practice
Perceive and react to new stimuli	Demonstration and imitation Task-oriented learning On-demand learning
Evaluate things ethically and act ethically	Teaching the scientific method Open education Learning through teaching Free work Project-based learning Gamification Reflective practice Collaborative learning
Organise	Demonstration and imitation Task-oriented learning Project-based learning Circuit-based learning Gamification
Adjust (machines/devices)	Demonstration and imitation Task-oriented learning Learning through teaching Circuit-based learning Gamification On-demand learning
React with support	Demonstration and imitation Task-oriented learning Circuit-based learning On-demand learning
React autonomously	Practice and repetition Demonstration and imitation Task-oriented learning
Respond in a complex way	Teaching the scientific method Open education Free work Project-based learning On-demand learning Reflective practice Collaborative learning
Adapt	Demonstration and imitation Task-oriented learning Gamification Project-based learning

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Learning objectives	Didactic methods
	On-demand learning
Create/create new things	Teaching the scientific method Open education Learning through teaching Free work Project-based learning Gamification Reflective practice Collaborative learning

Source: Planning the Use of Augmented and Virtual Reality for Vocational Education and Training – A Practical Guide

Below are the sheets of 10 "**Educational scenarios**" whose characteristic is that of being applicable, in broad terms, to different sectors including the sectors relating to the VIRTUAL project, i.e. hospitality and catering.

1. **ENGAGING WITH MACHINES**
   ACQUIRING A DEEPER COMPREHENSION OF COMPLEX TOOLS
2. **MOTOR SKILLS DEVELOPMENT**
   PRACTICE OF SPECIFIC MOVEMENT SEQUENCES
3. **AVATAR INTERACTION**
   SIMULATIONS INVOLVING VIRTUAL HUMAN FIGURES
4. **HANDLING UNFAMILIAR SITUATIONS**
   BEHAVIORAL TRAINING TO PREPARE FOR UNEXPECTED SITUATIONS
5. **SAFETY AND ACCIDENT PREVENTION**
   TRAINING TO MITIGATE RISKS AND UNDERSTAND SAFETY PROTOCOLS
6. **DEVELOPMENT OF PROFESSIONAL SKILLS**
   VOCATIONAL TRAINING TAILORED TO DIVERSE FIELDS OF EXPERTISE
7. **UNDERSTANDING NATURAL PHENOMENA AND PHYSICS**
   EXPLANATION OF SCIENTIFIC PRINCIPLES AND PHENOMENA
8. **ENHANCING SOCIAL COMPETENCIES**
   TRAINING TO ENHANCE COMMUNICATION AND INTERPERSONAL SKILLS
9. **ETHICAL DECISION-MAKING**
   TRAINING TO PROMOTE REFLECTION ON THE ETHICAL IMPLICATIONS OF ACTIONS
10. **EMPLOYING AUTHORING TOOLS**
    UTILIZING DESIGN ENVIRONMENTS TO DEVELOP AR/VR LEARNING SCENARIOS

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1. Engaging with machines

Acquiring a deeper comprehension of complex tools

Application in professional situations

The objective of projects within this Educational Scenario is to acquaint learners with the functioning of machines and plants (cluster). The goal is to equip them with the skills to operate these machines proficiently and, when required, to undertake maintenance and repairs. Utilizing representation in a 3D environment is adopted as a method to illustrate intricate details that may not be readily observable in real-life settings. Furthermore, immersing learners in machine operations within this environment aims to evoke emotional engagement with the subject matter.

In tourism sector, this Scenario can be applied to teaching for the use of some machines such as: equipment present in kitchens, laundry, heating and electrical systems, equipment for cleaning and sanitizing environments, sports and fitness equipment in hotels, etc.

Technological requirements

Virtually any technical setup offers opportunities for understanding and interacting with machines. Presently, Virtual Reality (VR) sees significantly greater use than Augmented Reality (AR), often employing computer-generated Digital Twins in lieu of enhancing actual machinery. Input devices providing six Degrees of Freedom (DoF) prove most conducive to creatively operating and exploring these machines, enabling users to intuitively handle virtual objects. the AR, in particular, assists in maintenance and repair activities with interactive guides for technicians. Can be used also haptic devices (such as gloves or haptic vests) that convey the sense of touch to the user through vibrations, enhancing virtual experiences.

Target

The scenario is broadly applicable to all target groups, but it proves especially beneficial for trainees and young adults/newcomers to careers.

Learning objectives

Given the "limited" use of machinery and equipment in the tourism sector, the conceivable learning objectives of adapted/revised Bloom's taxonomy are main:

- Understand
- Apply
- Adjust

Didactic methods

Task-oriented learning; Teaching the scientific method; Learning through teaching; Project-based learning; On-demand learning; Collaborative learning; Practice and repetition; Demonstration and imitation; Circuit-based learning; Gamification

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2. Motor skills development

Practice of specific movement sequences

Application in professional situations

In this educational scenario, occupational movement sequences are practiced within a risk-free environment. Much like gaming applications that refine sports techniques such how to bowl or yoga techniques/movements, this scenario focuses on precision and consistency in Motor Skills training. Tasks useful to realize interlocking assembly, as creating interlocking joints between wooden pieces using techniques such as dovetail or mortise and tenon cuts, which require precision in marking and cutting the wood for a perfect fit. Additionally, Assistance Systems provide real-time feedback on incorrectly executed movements, offering advantages over real-world practice. This allows for self-directed learning without the need for corrective interventions from a trainer.

In tourism sector, this Scenario can be applied to teaching some movements and techniques, for example how to dust, how to make beds, how to load a dishwasher.

Technological requirements

Virtual reality (VR) systems that enable and can capture movements within a space, for example, through controllers (devices) and suitable tracking systems (such as inside-out tracking), offer valuable options in this regard. Depending on the extent of technical advancement, it may also be worth considering systems capable of recognizing finger positions or other body postures. Additionally, tactile input systems that provide haptic feedback could be beneficial for motor skills training, especially if these systems undergo further development in the future.

Target

The entire range of target groups can be catered to, encompassing trainees, young skilled workers currently employed in the field, and even seasoned professionals. This includes individuals at beginner, intermediate, and advanced proficiency levels.

Learning objectives

- Remember
- Understand
- Apply

Didactic methods

Practice and repetition; Demonstration and imitation; Task-oriented learning; Teaching the scientific method; Learning through teaching; Project-based learning; On-demand learning; Collaborative learning; Practice and repetition; Demonstration and imitation; Task-oriented learning; Circuit-based learning; Gamification

3. Avatar interaction

Simulation involving virtual human figures

Application in professional situations

In this educational scenario, emphasis lies on tactile or haptic interaction with individuals, particularly in diagnostic or emergency contexts. Consequently, projects within this domain often address nursing or medical procedures. Nursing care and emergency medicine present ample opportunities for novice practitioners to err. Conducting training on real patients entails risks. These VR systems are equipped to provide feedback on the accuracy of treatment procedures.

In tourism sector, this Scenario does not find widespread application. In some cases, hotel staff may assist guests with reduced mobility in entering or exiting hotel/restaurant facilities, providing physical support such as offering an arm for assistance. If the hotel offers spa services such as massages, facials, or body treatments, there will be direct physical contact between the therapist and the client during the session.

Another situation is about guests' sudden health issues requiring immediate medical assistance, such as heart attacks, strokes, allergic reactions, or injuries. It is important for staff to be trained in first aid.

Technological requirements

Similar to motor skills development, virtual reality systems are beneficial in this context as well, provided they can accurately capture movements within real-world spaces using suitable input methods (such as controllers) and tracking systems (e.g., inside-out tracking) and replicate them in VR environments. In the future, systems with enhanced tracking capabilities (such as recognizing individual fingers or entire body postures) and tactile input systems (capable of providing features like haptic feedback) will also become increasingly relevant.

Target

The primary beneficiaries of this educational scenario are trainees, newcomers to the field, and seasoned professionals alike.

Learning objectives

Given the "limited" practice of activities involving physical contact with client in tourism and restaurant sector

- Understand
- Apply

Didactic methods

Task-oriented learning; Teaching the scientific method; Learning through teaching; Project-based learning; On-demand learning; Collaborative learning; Practice and repetition; Demonstration and imitation; Circuit-based learning; Gamification

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4. Handling unfamiliar situations

Behavioral training to prepare for unexpected situations

Application in professional situations

Certain scenarios require practice despite the hope that they never materialize. Traditional learning methods, like first aid courses or fire safety drills, address these types of training areas. These practices can also be replicated in Virtual Reality (VR) or Augmented Reality (AR). The goal is to enable trainees to fully grasp and internalize specific sequences, empowering them to take appropriate actions in unexpected situations. The advantage of such simulations is the ability to practice emergency scenarios without risking harm to individuals or property.

In tourism sector, this Scenario can be applied to teaching how to react in a lot of possible situations as:

- Fires: it can start due to various causes such as short circuits, overheating of electrical appliances, open flames, or smoking.
- Thefts or Crimes: Hotels may be subject to thefts, robberies, or other criminal acts. Effective security measures such as video surveillance systems, security personnel, and protocols for managing emergency situations are important.
- Floods or Gas Leaks: Pipe malfunctions or gas leaks can cause floods or hazardous situations.
- Extreme Weather Conditions: Thunderstorms, floods, hurricanes, or other extreme weather conditions can pose a danger to guests and structures.
- Terrorist Attacks or Security Threats.

It’s very important for hotel and restaurants s to have well-defined emergency plans and for staff to be trained to respond appropriately to any emergency situation that may arise.

Technological requirements

Technical setups are advantageous when they allow for a greater number of Degrees of Freedom, enabling a wider range of movement, and when actions can be controlled directly using controllers or similar devices. This is an area where ongoing technological advancements, particularly in the realm of Haptic Feedback, will become increasingly relevant in the future. Additionally, the more immersive the learning environment—due to factors such as the use of Head-Mounted-Displays, a lifelike VR setting, and convincingly designed avatars—the more emotionally engaging and comprehensive the learning experience will be.

Target

Experienced personnel are marginally more prone to being approached, yet this scenario encompasses youthful individuals capable of engaging in novel scenarios at both introductory and proficient tiers.

Learning objectives

- Understand
- Apply
- Analyse

Didactic methods

Task-oriented learning; Learning through teaching; Project-based learning; On-demand learning; Collaborative learning; Practice and repetition; Demonstration and imitation; Circuit-based learning; Open education; Free work

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5. Safety and accident prevention

Training to mitigate risks and understand safety protocols

Application in professional situations

In this educational scenario, it is possible to monitor workers' performance during safety training, identifying any areas for improvement and providing real-time feedback. With virtual reality, realistic training simulations can be created on topics such as ladder safety, the use of protective equipment, or heavy load management.

Employing a virtual reality (VR) learning environment presents the chance to breathe life into mundane content, even within classroom-based teaching and learning settings. The dynamic nature of VR aids in fostering a deeper comprehension of the rationale behind specific regulations.

In tourism sector, this Scenario can be applied to teaching how to adopt procedures related to food safety, personal hygiene, and the correct use of equipment, for example in catering activities (such as the use of kitchen knives, techniques for oven use, safe disposal of food waste, and separation of hazardous waste, etc.). Particular in restaurant activities, is important to understand basic principles of food safety, such as safe food handling, prevention of cross-contamination, and safe food storage, to ensure compliance with health regulations and prevent foodborne illnesses.

Technological requirements

This scenario is utilized for replicating technical facilities like fire extinguishers, ovens, knives, and other potentially hazardous utensils, allowing for the practice of pertinent prevention and safety protocols. Replicating such devices within a computer-generated environment can be both time-consuming and costly, though utilizing existing CAD data can expedite this process. Moreover, this learning scenario leverages multiple Degrees of Freedom (DoF). Furthermore, a Digital Twin must encompass comprehensive settings to accurately replicate fault or emergency situations.

Target

Beginners in these thematic fields, namely, the primary target consist of young individuals in training and young adults/newcomers to the workforce. Nevertheless, experienced personnel can also be engaged. Undoubtedly, the VR environment enhances participants' motivation.

Learning objectives

- Understand
- Apply

Didactic methods

Practice and repetition; Demonstration and imitation; Task-oriented learning

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6. Development of professional skills

Vocational training tailored to diverse fields of expertise

Application in professional situations

This educational cluster encompasses all projects and applications aimed at imparting occupation-specific competencies. Some may cater to multiple occupational groups (e.g., an application focusing on spatial vision), while others are tailored for trainee chefs or personnel in the printing industry, for instance.

When referring to Professional Competencies, it's not just about specialized knowledge but also about applying this knowledge in various situations, including unfamiliar ones. In other words, the emphasis is on Employability Skills.

Therefore, all outlined learning objectives and instructional concepts are potential options. To define the learning objective, the nature of the respective professional competencies must be specified in more detail. The relevant training regulations or standards for professional competence can serve as starting points in this regard.

In tourism sector, this Scenario can be applied to a lot of situations such as registering arriving guests, assigning rooms, preparing meals, and serving at the table but also how to promote the company, how to monitor the budget, and optimize profitability, to name just a few examples among many.

Technological requirements

The diverse array of applications compiled within this cluster makes it challenging to offer universally applicable recommendations regarding technical configurations. However, initial points of reference can be derived from the other educational scenarios described previously and their corresponding learning objectives.

Target

Employment-focused learning initiatives employing AR/VR could theoretically benefit all target, but they are particularly well-suited for young individuals/trainees and young adults at introductory levels. Furthermore, individuals with disabilities can be effectively targeted as well.

Learning objectives

Depending on professional skills to be trained

Didactic methods

Depending on professional skills to be trained

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7. Understanding natural phenomena and physics

Explanation of scientific principles and phenomena

Application in professional situations

In this educational scenario, while this AR/VR Learning Scenario does concentrate on specialized knowledge, its main focus lies on traditional STEM subjects, such as computer technology and the sciences. The rote memorization of formulas and definitions can deter many young individuals, yet there is considerable potential in experiencing natural and technical phenomena firsthand through AR/VR. Game-based scenarios serve as the primary starting point, accentuating the experiential and experimental aspects of the sciences.

In tourism sector, this Scenario can be applied to teaching different kind of possible activities:

- Financial management, to manage inventory, calculate costs and revenues, set prices, place supply orders, and manage the overall budget.
- Measurement and conversions, knowledge of basic units of measurement and conversions used in the kitchen, such as grams, milliliters, ounces, cups, etc.
- Proportions and dilutions: proportions and dilutions for preparing beverages and cocktails, mixing condiments and sauces and maintaining consistency in dishes served.
- Knowledge of ingredients and food allergies, being aware of the ingredients used in dishes, potential food allergies, and dietary restrictions of customers, to provide accurate and safe information and to prepare dishes suitable for various dietary needs.
- Ability to calculate percentages: to calculate percentages for discounts, tips, price increases, or to determine the composition of a mixture of ingredients.
- Problem-solving skills, to solve sudden or complex mathematical problems that may arise during daily operations, such as currency calculations, order corrections, or workflow management.

Technological requirements

The diverse array of applications compiled within this cluster makes it challenging to offer universally applicable recommendations regarding technical configurations. However, initial points of reference can be derived from the other educational scenarios described previously and their corresponding learning objectives.

Target

Employment-focused learning initiatives employing AR/VR could theoretically benefit all target, but they are particularly well-suited for young individuals/trainees and young adults at introductory levels. Furthermore, individuals with disabilities can be effectively targeted as well.

Learning objectives

Depending on skills to be trained

Didactic methods

Depending on skills to be trained

8. Enhancing social competencies

Training to enhance communication and interpersonal skills

Application in professional situations

About this educational scenario, some argue that personal competencies such as interaction skills, communication skills, or leadership skills cannot be effectively taught using digital learning tools. They contend that a face-to-face approach and direct interaction with a teacher are the only effective methods, especially when considering more conventional learning tools like e-books or web-based trainings. However, AR/VR educational Scenarios aimed at imparting social competencies also prioritize practical skills through interactions with other individuals (or avatars) in an AR or VR environment. One advantage of this approach is the creation of a “protected space”, which helps overcome inhibitions. In this environment, there's no need to fear scrutiny from others while working to improve communication skills.

In tourism sector, this Scenario can be applied to teaching, at least, how to:

- Communicate effectively with guests, colleagues, and other stakeholders. This includes verbal communication, active listening, and non-verbal communication skills.
- Being empathetic, cooperative, and diplomatic in interactions with others.
- Collaborate and work in team and contribute to achieving common goals
- Think critically and solve problems quickly and effectively is important in the fast-paced and dynamic environment. This includes being resourceful, adaptable and proactive in addressing challenges
- Understand and empathize with guests' feelings and perspectives
- Being adaptable and flexible in responding to changing circumstances.

Technological requirements

Multiple initiatives employ 180° or 360° videos showcasing activities that learners can observe from different perspectives. In contrast to traditional instructional videos, 360° videos offer an immersive quality, enhancing learners' sense of participation and emotional engagement. Certain scenarios are designed for learners to engage from a stationary position, while others benefit from freedom of movement within virtual reality (VR) environments. When selecting augmented reality (AR) or VR equipment, it's essential to consider these configurations and ensure compatibility with the necessary technical specifications, such as Degrees of Freedom (DoF).

Target

The target audience comprises trainees and young adults new to their careers, though they may also include educators and teaching/training staff.

Learning objectives

Understand; Analyze; Evaluate; Perceive and react to new stimuli

Didactic methods

Reflective practice; Demonstration and imitation

9. Ethical decision making

Training to promote reflection on the ethical implications of actions

Application in professional situations

In this educational cluster, learning applications cover a range of educational scenarios, including exercises utilizing avatars, motor skills development, handling with unfamiliar situations and enhancing social competencies. In addition to these learning objectives, learning applications may also aim to instill ethical principles and prompt users to reflect on their actions. This might entail encouraging actions that benefit others or presenting scenarios where actions are taken to prevent harm to others.

In tourism sector, this Scenario can be applied to teaching how to:

- adopt sustainable practices to reduce the hotel/restaurant's environmental impact, such as energy conservation, waste recycling, responsible water usage, and the use of eco-friendly materials.
- ensure an inclusive and diverse work environment, promoting equal opportunities, and respecting all individuals regardless of race, gender, sexual orientation, or religion.
- collaborate with local organizations and initiatives to support the socioeconomic development of host communities.
- inform and raise awareness among guests about the importance of responsible and sustainable tourism, offering eco-friendly options, and promoting cultural and recreational activities that respect local traditions and the environment.

Technological requirements

This is another field where a diverse range of VR and AR systems can be utilized. However, basic technical setups suffice here as extensive Degrees of Freedom (DoF) aren't essential. The game environments portrayed can be comfortably observed while standing or sitting in a three-dimensional space (3D), without requiring users to interact using controllers. Instead, controlling the VR application through eye movements alone may suffice.

Target

These educational applications target younger, including young adults. Nonetheless, they can also cater to teaching staff.

Learning objectives

- Understand
- Evaluate things ethically and act ethically

Didactic methods

Gamification; Reflective practice; Collaborative learning; Task-oriented learning

10. Employing authoring tools

Utilizing design environments to develop AR/VR learning scenarios

Application in professional situations

Previous Educational Scenarios were centered around achieving specific learning objectives. This scenario delves deeper into the realm of utilizing tools to forge entirely new AR/VR experiences tailored for a myriad of applications. These Authoring Tools serve as the catalyst, enabling users to seamlessly amalgamate an array of external elements into the virtual landscape. This encompasses everything from intricate 3D objects to specialized content, along with video and audio files, and interactive elements such as quizzes. Their overarching objective lies in the construction of virtual Learning Scenarios that possess the adaptability to be repurposed across diverse educational contexts, thereby circumventing the necessity for extensive reprogramming efforts with each iteration. This represents an inaugural stride towards the standardization of AR/VR content and its underlying structural framework. In this cluster, learning applications cover a range of educational scenarios, including exercises utilizing avatars, motor skills development, handling with unfamiliar situations and enhancing social competencies. In addition to these learning objectives, learning applications may also aim to instill ethical principles and prompt users to reflect on their actions. This might entail encouraging actions that benefit others or presenting scenarios where actions are taken to prevent harm to others.

In tourism sector, this Scenario doesn't change, because the Authoring Tools applicable by teachers/trainers are the same that for other sectors.

Technological requirements

Often, these authoring tools are built upon commercially available development environments.

Target

These educational applications are targeted to teaching/training staff.

Learning objectives and Didactic methods

Authoring tools enable the realization of diverse scenarios without requiring specialized software expertise. Consequently, a broad spectrum of learning objectives and didactic concepts can be implemented, tailored to individual use cases.

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