DIGITAL.VET
DIGITAL TEACHING IN VET SYSTEM

IO1

Handbook of Flipped/Mobile/ Virtual&Augmented Reality Learning Programme applied to Vocational Training

short version

Project No: 2019-1-PL01-KA202-065064

Co-funded by the Erasmus+ Programme of the European Union

Disclaimer

The views represented in this document only reflect the views of the authors and not the views of the Ruropean Union. The European Union is not liable for any use that may be made of the information contained in this document. Furthermore, the information is provided „as is" and no guarantee or warranty is given that the information is fit for any particular purpose. The user of the information uses it at its sole risk and liability.

Project Partners

Akademia Humanistyczno Ekonomiczna w Łodzi

StudioRisorse

afn ACADEMIA FORMAÇÃO NORTE

iInformatic@

CPI CENTER RS ZA POKLICNO IZOBRAŽEVANJE

INNETICA EUROPEAN NETWORK

For full details of partners go to https://www.digitalvet.eu/

Co-funded by the Erasmus+ Programme of the European Union

This project has been funded with support from the European Commission. This communication reflects the views only of the authors and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Table of contents

1. INTRODUCTION

DIGITAL.VET project develops several outputs and activities to improve the VET trainers and teachers' capacity to use digital, immersive and Cloud Computing technologies in the teaching activities.

It is expeted to develop during the project the following products:

1. Handbook of Flipped/Mobile/Virtual&Augmented Reality Learning Programme applied to Vocational Training.
2. Competence profile of "Experts in digital and immersive teaching for vocational training".
3. E-learning course for "Experts in digital and immersive teaching for vocational training".
4. iDid: Application for digital and immersive teaching, through which teachers / trainers will be able to develop activities / teaching phases in virtual and augmented reality.
5. Pathway to Competence Assessment and Self-Assessment of "Experts in digital and immersive teaching for vocational training", based on skills certification tools according to the ECVET System.

Today, digital teaching methods assume a strategic importance for the development of a Vocational Education and Training (VET) System in step with the times, able to adapt quickly to technological, social, cultural and economic changes. The VET teacher/trainer is called to reflect the current cultural dynamism and to meet the needs of his students, so-called digital natives, through the use of open spaces for learning, which favor inclusive and fair conditions for all.

The DIGITAL becomes an indispensable tool for the VET trainer, because it enables the use of innovative and effective teaching practices, close to the social language of the students, stimulating their motivation and interest in the subject treated.

The project is part of these priorities because it intends to improve the technical preparation of Teachers and Trainers of Training Agencies, Institutes and Vocational Training Centers, both public and private, operating in VET system, on the use of digital and immersive teaching methods as a support tool for learning, student motivation and the consequent reduction of the drop-out rate, social and digital inclusion.

In particular, it improves their digital skills in teaching practice, participating in the online training course for VET qualification, built on the basis of Job analysis and Job description of the Competence profile "Expert in digital and immersive teaching for vocational training", produced by the project.

In order to promote the introduction of digital, immersive teaching methods and Cloud services within the VET System, a European-level Research will also be carried out

to identify the best practices of Flipped / Mobile / Virtual & Augmented Reality Learning applied to the VET System, to be made available to VET teachers and trainers through a multilingual HANDBOOK, and to create an iDid – an application for digital and immersive teaching, aimed at developing lessons / learning units in virtual and augmented reality by teachers / trainers, continuously updated and available to all, and to provide an assessment and self-assessment path for teachers and trainers.

The following document is the first Intellectual output in the DIGITAL.VET project. Its aim is to introduce three models of learning methodologies:

1. Flipped Learning model
2. Mobile Learning model
3. Virtual and Augmented Reality Learning model.

2. HANDBOOK OF LEARNING PROGRAMME – THE IDEA

The proposed "Hanbook of Flipped/Mobile/Virtual&Augmented Reality Learning Programme applied to Vocational Training" has as a purpose to presnts the teaching models of Flipped, Mobile and Virtual and Augmented Reality (VR & AR) Learning specially designed for VET in order to develop one or more skills described in "A New Skills Agenda for Europe" by the EC.

These methodologies are chosen according to both the context and the needs analysis that the partnership hascarried out on the use of digital and immersive teaching. The survey highlighted the need for digital skills and for the use of VR (virtual reality) and AR (Augmented reality) in teaching programmes.

Each teaching model that was chosen has to be described taking into consideration the following elements:

- introduction to the relevant methodology used (Flipped, Mobile, VR e AR Learning) providing definition, fields and methods of application, necessary resources, advantages, risks, examples of good practices on the use of the methodology in other educational contexts and/ or in other sectors,
- activities/phases that make up the teaching model, such as the use of contents, individual or group learning, working out of contents, accomplishment of the tasks and practical activities, assessment and self-assessment phase, class management etc.,
- educational resources: texts, audiovisual products, multimedia products, video lessons, etc.,
- technologies: PCs, notebook, tablet, smartphone, applications, cardboard, cross-platform software, etc.,
- learning topics and places,
- communication channels,

- usability conditions,
- practical examples of teaching programmes using the Flipped classroom, Mobile and VR&AR Learning to develop special VET-related skills.

Therefore, some learning units can be presented on how to apply these methodologies to different professional disciplines.

The innovation elements of the proposed handbook are:

1. **Contents**: at a European level and in the territories involved there are already flipped classroom teaching programmes and learning units for school education. On the contrary, as for the VET courses almost nothing has been implemented as for the use of Flipped Classrooms, VR and AR, which are the ultimate and current teaching challenges in EU, better known as “immersive teaching”.
2. **Target group**: up to the present time, many actions have been carried out within the framework of Erasmus+ and in general within the framework of National policies to consolidate the digital skills of teachers offering them training opportunities and experimentation of digital teaching practices and models. However, VET trainers and teachers claim the lack of structured programmes and teaching opportunities that allow to acquire the technical and teaching skills relative to the application of teaching models using digital, mobile, virtual and augmented reality resources.
3. **Methodology used**: both the desk and on-field research will be carried out through innovative techniques aiming at guaranteeing quality, efficiency as well as cost reduction (CAWI methodology, Skype interviews, use of social network). Moreover, the focus groups will be carried out using an innovative methodology as a supplement to questionnaires and they will be based on facilitation methodologies and visualisation techniques such as mind maps and Goal Oriented Project Planning.

The impact of the proposed handbook is given at several levels:

1. VET TEACHERS AND TRAINERS participating in the development of the output:
   - Exchange on methodologies and production tools at European level
   - increase their skills in the teaching models of Flipped, Mobile and VA and AR Learning within VET sector
   - special teaching programmes to be used in their teaching activities based on digital and immersive teaching models for the development of vocational skills.
2. PARTNERS:
   1. higher qualified staff for the teaching programmes selected

2. innovative teaching programmes to be applied during VET courses.
3. TARGET GROUP (VET teachers/trainers) and STAKEHOLDERS (public and private vocational training centres): they will access, use and exchange ideas about an innovative digital teaching specially designed for VET.

3. FLIPPED LEARNING

In the *traditional model of classroom* instruction, the teacher is typically the central focus of a lesson and the primary disseminator of information during the class period. This *teacher-centred approach* implies that the teacher responds to questions while students defer directly to the teacher for guidance and feedback. Student engagement in the traditional model may be limited to activities in which students work independently or in small groups on an application task designed by the teacher. Class discussions are typically teacher-centred, the teacher usually controls the flow of the conversation. Typically, this pattern of teaching also involves giving students the task of reading from a textbook or practicing a concept by working on a problem set, for example, outside school.

The **flipped learning/classroom** intentionally shifts instruction to a *learner-centred model* through which it is possible to explore topics in a greater depth and create more meaningful learning opportunities during the in-classroom activities, while educational technologies such as online videos are used to deliver content outside of the classroom. In a flipped classroom, content delivery may take a variety of forms. Often, video lessons, assignments, self-evaluation tests prepared by the teacher or third parties are used to deliver content, although online collaborative discussions, digital research, and text readings may be used.

Taking into consideration the Bloom's taxonomy it is easy to notice that flipped model is focused on the student. Instructors focus on higher level learning outcomes during class time and lower level outcomes outside of class. This means the flip could be as simple as watching a video before class and then attending class for more in-depth discussions that involve judging, analysing, and creating. If students work with the fundamental material before class, they are better prepared to apply the information and engage in higher-level discussions with their peers and the instructor (Fig. 1).

3.1. Definition of flipped model

Flipped classroom is a learning environment in which the activities traditionally completed outside of class as a homework are now completed in class during instruction time. Moreover, the activities traditionally completed in class are now completed on students' own time before class, for example students watch a video of pre-recorded lectures before class. Then, when they arrive to class, they work through assignments or activities with their peers and the instructor.

Many models however start with face-to face contact first, followed by different out of class activities. While that is probably the most familiar idea of the flipped classroom, flipping can mean more than watching videos of lectures. It involves completing different online activities, tests, quizzes, etc, which can be checked by the educator prior the class.

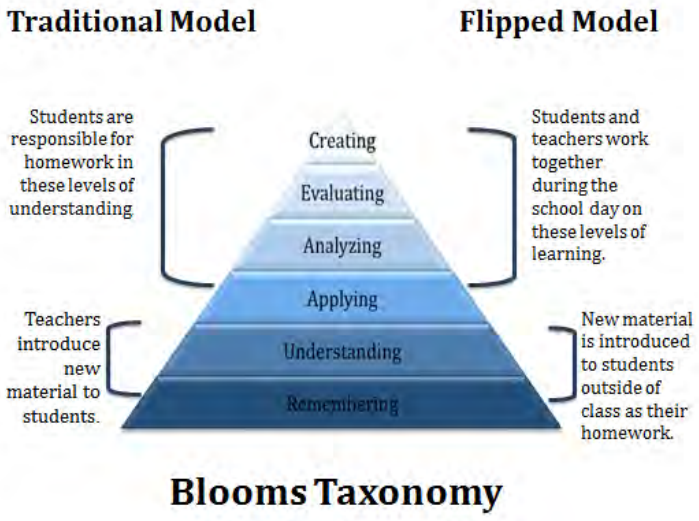


Fig. 1. Bloom's Taxonomy applied to traditional classroom activities and flipped classroom activities [http://nextgenerationextension.org/2013/10/01/blooms-and-the-flipped-classroom/]

One of the essential goals of the flipped classroom is to move beyond the lecture as the primary way to deliver information and knowledge and structure class time. A well-developed lecture can be effective, but instructors rely on it too heavily and often to the exclusion of other more meaningful teaching and learning strategies. Flipped classroom can also be described as moving from an instructor-centred learning environment to a student-centred learning environment. It could also be defined as shifting from individual to collaborative strategies. Although, it is possible to flip a class using individual activities such as quizzes, worksheets, reflective writing prompts, and problem solving assignments. The key is to complete these activities during class time (Fig. 2).

3.2. Four pillars of flipped classroom

The team of educators from the Flipped Learning Network, along with Pearson's School Achievement Services (2013), identified the key features, or pillars, of flipped classrooms that allow Flipped Learning to occur. The four Pillars of F-L-I-P are as follows:

- **Flexible environments**: Teachers must expect that class time will be "somewhat chaotic and noisy" and that timelines and expectations for learning assessments will have to be flexible as well. Flipped classrooms allow for a variety of learning modes; educators often physically rearrange their learning space to accommodate the lesson or unit, which might involve group work,

independent study, research, performance, and evaluation. They create Flexible Environments in which students choose when and where they learn.

- **Learning culture**: The classroom becomes student-centred. According to the guide: "Students move from being the product of teaching to the centre of learning, where they are actively involved in knowledge formation through opportunities to participate in and evaluate their learning in a manner that is personally meaningful." Students can theoretically pace their learning by reviewing content outside the group learning space, and teachers can maximize the use of face-to-face classroom interactions to check for and ensure student understanding and synthesis of the material.
- **Intentional content**: Teachers are required to evaluate what they need to teach directly so that classroom time can be used for other methods of teaching, such as "active learning strategies, peer instruction, problem-based learning, or mastery or Socratic methods, depending on grade level and subject matter."
- **Professional educators**: The instructional videos used for flipped classrooms cannot replace trained, professional teachers. In the Flipped Learning model, skilled, Professional Educators are more important than ever, and often more demanding, than in a traditional one. They must determine when and how to shift direct instruction from the group to the individual learning space, and how to maximize the face-to-face time between teachers and students. During class time, educators continually observe their students, provide them with feedback relevant in the moment, and continuously assess their work.

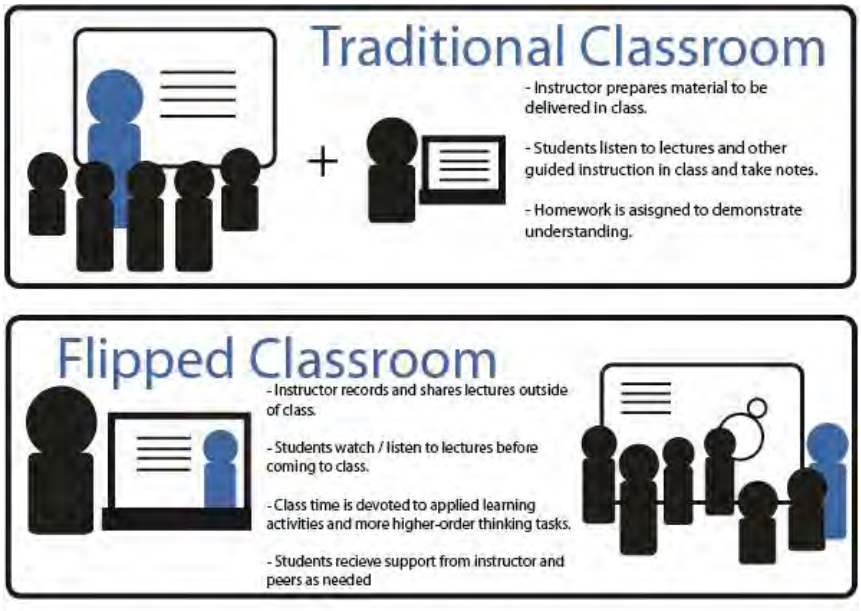


Fig. 2. Traditional classroom activities and flipped classroom activities [http://www.slu.edu/cttl/resources/teaching-tips-and-resources/flipped-classroom-resources]

3.3. Phases of Flipped classrom

The advantage of the flipped classroom is that the content, often the theoretical/lecture-based component of the lesson, becomes more easily accessed and controlled by the learner. One of the major, evidenced-based advantages of the use of video is that learners have control over the media with the ability to review parts that are misunderstood, which need further reinforcement, and/or those parts that are of particular interest. When educators are asked to replace their in-class lectures with videotaped ones (either their own or others) that learners watch at home, educators may not know what to do with this now void in-class time. Those who advocate for the flipped classroom state that class time can then be used for discourse and for providing hands-on, authentic learning experiences.

For educators, who are used to and use the didactic model, a framework is needed to assist them with the implementation of the Flipped Classroom.

What follows is an explanation of the Flipped Classroom Model, a model where the video lectures and podcasts fall within a larger framework of learning activities. It is a cycle of learning model, which provides a sequence of learning activities based on the learning theories and instructional models of Experiential Learning Cycles: http://reviewing.co.uk/research/learning.cycles.htm and Bernice McCarthy's 4MAT Cycle of Instruction: http://www.aboutlearning.com/what-is-4mat/what-is-4mat (Fig. 3).

Phase1: Experiential Engagement: The Activity

The cycle often begins with an experiential exercise. This authentic, often hands-on learning activity fully engages the student. It is a concrete experience, which calls for attention by most, if not all, the senses. Learners become "hooked" through personal connection to the experience and desire to create meaning for and about that experience (*constructivist learning*).

Setting: These activities are designed for in-class time and often occur in a group setting. In a blended course, these are synchronous activities conducted during face-to-face instructional time. In an online course, students could be asked to go to a community event, museum, . . or the creative educator could provide some type of hands-on activity or simulation for students to complete during a real-time synchronous webinar session via Adobe Connect, Elluminate or through a 3D Learning experience.

Phase 2: Conceptual Connections: The What

Learners are exposed to and learn concepts touched upon during *Experiential Engagement*. They explore what the experts have to say about the topic. Information is presented via video lecture, content-rich websites and simulations like PHET and/or

online text/readings. In the case of the flipped classroom this is the time in the learning cycle when the learners view content-rich videos.

Concepts should be presented in accessible form. By providing learners with online resources and downloadable media, learners can control when and how the media is used. This is the major value of flipping the classroom. Content-based presentations are controlled by the learner as opposed to the lecturer as would be the case in a live, synchronous, didactic-driven environment.

Setting: These materials are used by the learners in their own setting on their own time. In other words, students have the opportunity to access and interact with these materials in a personalized manner. They can view them in a learning setting that works for them (music, lighting, furniture, time of day) and can view/review information that they find particularly interesting or do not understand. It is asynchronous learning and as such permits the learner to differentiate learning for him/herself.

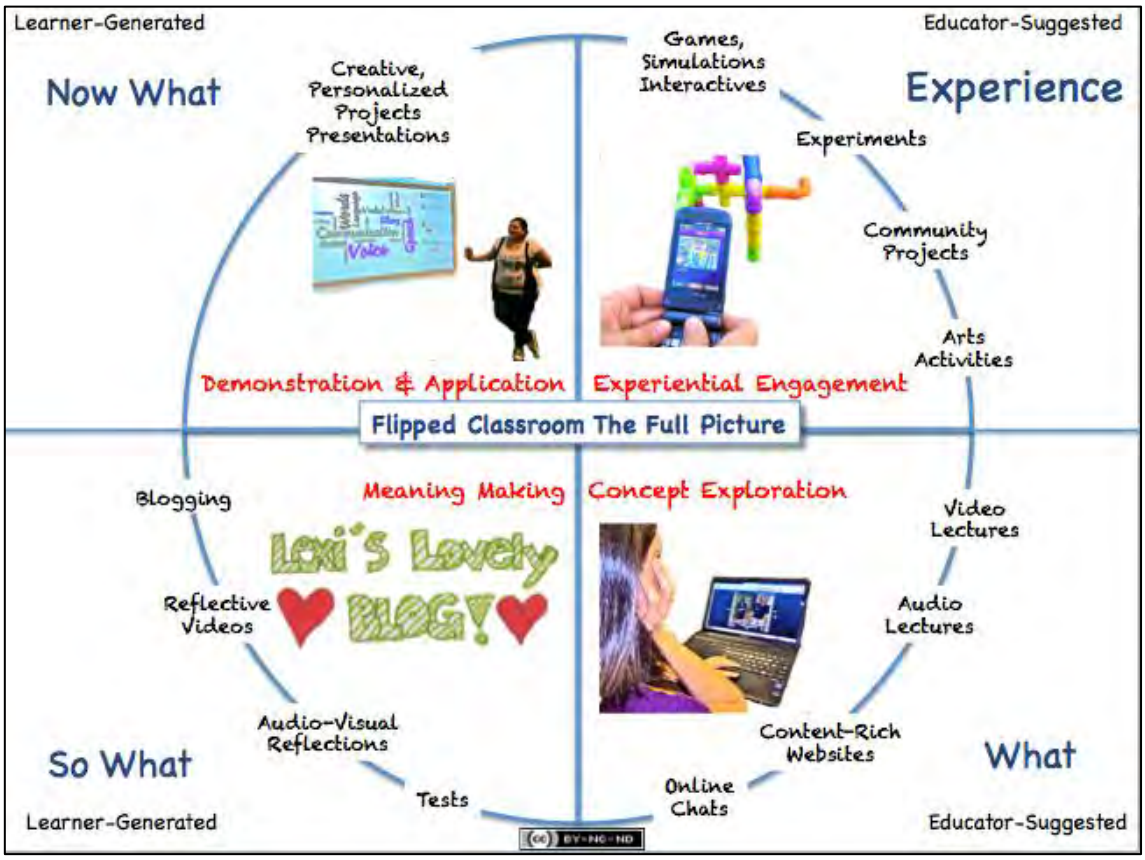


Fig. 3. Phases of flipped learning activities

Phase 3: Meaning Making: The So What

Learners reflect on their understanding of what was discovered during the previous phases. It is a phase of deep reflection on what was experienced during the first phase and what was learned via the experts during the second phase.

Learners can articulate and construct their understanding of the content or topic being covered through written blogs or verbal-based audio or video recordings. Within the standard school system, this would be the phase when students are tested about their understanding of the content. If this is the case, it is recommended that the tests target higher levels of Bloom's Taxonomy – evaluation, applying, synthesizing.

Setting: If possible, learners should be given the opportunity to reflect upon and make meaning of the content-related concepts within their own time schedule . . . both at a time when they feel ready to do so and taking the time they personally need for producing self-satisfactory work.

Phase 4: Demonstration and Application: The Now What

During this phase, learners get to demonstrate what they learned and apply the material in a way that makes sense to them. This goes beyond reflection and personal understanding in that learners have to create something that is individualized and extends beyond the lesson with applicability to the learners' everyday lives. This is in line with the highest level of learning within Bloom's Revised Taxonomy of Learning – *Creating* – whereby the learner creates a new product or point of view. In essence, they become the storytellers of their learning.

Setting: This phase of the cycle is best when it occurs in a face-to-face, group setting within the classroom. The reasons for recommending this type of synchronous learning are:

- the educator can guide the learner to the types of projects and tools best suited for him/her, and
- an audience of peers and mentors increases motivation and provides opportunities for feedback.

3.4. Flipped leraning models

There are exist some versions/models of Flipped Learning approach:

- **Standard Inverted Classroom:** Students are assigned the "homework" of watching video lectures and reading any materials relevant to the next day's class. During class time, students practice what they have learned through traditional schoolwork, with their teachers freed up for additional one-on-one time.
- **Discussion-Oriented Flipped Classroom:** Teachers assign lecture videos, as well as any other video or reading related to the day's subject – thank TED Talks, YouTube videos, and other resources. Class time is then devoted to discussion and exploration of the subject. This can be an especially useful approach in subjects where context is everything – think history, art, or English.

- **Demonstration-Focused Flipped Classroom:** Especially for those subjects that require students to remember and repeat activities exactly — think chemistry, physics, and just about every math class — it is most helpful to have a video demonstration to be able to rewind and rewatch. In this model, the teacher uses screen recording software to demonstrate the activity in a way that allows students to follow along at their own pace.
- **Faux-Flipped Classroom:** One great idea EducationDrive uncovered is perfect for younger students for whom actual homework might not yet be appropriate. This flipped classroom model instead has those students watch lecture video in class — giving them the opportunity to review materials at their own pace, with the teacher able to move from student to student to offer whatever individual support each young learner needs.
- **Group-Based Flipped Classroom:** This model adds a new wrinkle to helping students learn — each other. The class starts the same way others do, with lecture videos and other resources shared before class. The shift happens when students come to class, where they team up to work together on that day's assignment. This format encourages students to learn from one another, and helps students to not only learn the what the right answers are but also how to actually explain to a peer why those answers are right.
- **Virtual Flipped Classroom:** For older students and in some courses, the flipped classroom can eliminate the need for classroom time at all. Some college and university professors now share lecture video for student viewing, assign and collect work via online learning management systems, and simply require students to attend office hours or other regularly scheduled time for brief one-on-one instruction based on that individual student's needs.
- **Flipping The Teacher:** All the video created for a flipped classroom doesn't have to begin and end with the teacher. Students too can make use of video to better demonstrate proficiency. Assign students to their record practice role-play activities to show competency, or ask each to film themselves presenting a new subject or skill as a means to "teach the teacher".

3.5. Conlusions

Every classroom is different, with different levels of access to technology, different levels of motivation on the part of the students, and different technological know-how on the part of the instructors. Additionally, teachers must re-learn how to act as the "guide on the side" rather than the "sage on the stage" and it takes time.

Flipped classroom requires preparation and flexibility. However, when the shift does occur, many experts believe the benefits are well worth the effort.

4. MOBILE LEARNING

Mobile learning is the delivery of learning, education or learning support on mobile phones, PDAs or tablets.

A *theory of mobile learning* is essential when thinking of the role of mobility and communication in learning environments. (Sharples, Taylor, & Vavoula, 2005). In mobile learning, students learn across both space and time and move from topic to topic. Like a blended environment, learners move in and out of engagement with technology. A key point in mobile learning theory is that it is the learner that is mobile, not the technology (Shuler, 2009). As devices are ubiquitous, learning can be interwoven with activities part of everyday life. Control of mobile learning environments can be distributed, and context is constructed by learners through their interaction with devices and with each other. They acknowledge that mobile learning can both complement and conflict with format education, and it raises ethical issues both of privacy and ownership.

A literature review of mobile technologies and learning stated that a challenge for both educators and designers is one of knowing how to use mobile tools in the most meaningful way (Naismith, Lonsdale, Vavoula, & Sharples, 2004). The authors suggested that a blended learning approach is necessary when using mobile technologies in learning settings. That is, all instructional and learning activities do not necessarily need to be done using mobile phones, but rather those types of activities must be balanced out with other instructional and learning strategies.

M-learning or **mobile learning** is "learning across multiple contexts, through social and content interactions, using personal electronic devices". This is a form of distance education, because m-learners use mobile device educational technology at their convenient time.

M-learning technologies include handheld computers, MP3 players, notebooks, mobile phones and tablets. M-learning focuses on the mobility of the learner, interacting with portable technologies. Using mobile tools for creating learning aids and materials becomes an important part of informal learning.

M-learning is convenient in that it is accessible from virtually anywhere. Sharing is almost instantaneous among everyone using the same content, which leads to the reception of instant feedback and tips. It also brings strong portability by replacing books and notes with small devices, filled with tailored learning contents. M-learning has the added benefit of being cost effective, as the price of digital content on tablets is falling sharply compared to the traditional media (books, CD and DVD, etc.).

Shuler (2009) identified key opportunities in mobile learning such as:

- promotion of anytime,
- anywhere learning,

- ability to reach under served children (low cost, high accessibility),
- ability to improve 21st century social interaction,
- flexibility to fit into diverse learning environments and
- ability to enable a personalized learning experience.

4.1. The approaches of mobile learning

There were identified four areas where scholars, practitioners, vendors, and policy makers converge in discussions, implementation, and support of educational technologies (Dede & Bjerede, 2011):

1. devices and infrastructure,
2. safety and privacy,
3. digital assets and assessments,
4. and human capital.

Some of the possibilities offered by this methodology, according to Fombona, Pascual-Sevillana and González-Videgaray, are a greater and different access to information, along with transcendent innovations, such as the increase of informal and playful activities, iconic virtual, membership of specific groups, and networks of friendly interaction within new scales of values.

There are exists some kinds of approaches in mobile learnings – they are presented below:

Classroom

Applications in classrooms and other learning spaces combine the use of handheld computers, PDAs, smartphones or handheld voting systems (such as clickers) with traditional resources (Tremblay 2010).

Mobile devices in brick-and-mortar classrooms can be used to enhance student-centered learning, group collaboration among students through communication applications, interactive displays, and video features:

- existing mobile technology can replace cumbersome resources such as textbooks, visual aids, and presentation technology
- interactive and multi-mode technology allows students to engage and manipulate information
- mobile device features with WIFI capabilities allow for on-demand access to information
- access to classroom activities and information on mobile devices provides a continuum for learning inside and outside the classroom.

In a literature review conducted by FutureLab, researchers found that increased communication, collaboration, and understanding of concepts was a result of mobile technology applications.

Mobile devices can be used in online settings to enhance learning experiences in ***Distance Learning***:

- The mobile phone (through text SMS notices) can be used especially for distance education or with students whose courses require them to be highly mobile and in particular to communicate information regarding availability of assignment results, venue changes and cancellations, etc.
- Mobile devices facilitate online interaction between teacher and student, and student to student. Mobile devices make it possible to facilitate interaction in real time, allowing students to obtain immediate feedback. Educators can also assess student comprehension by using mobile devices, which provide real time updates on student progress, enabling teachers to adapt and personalize their teaching.
- It can also be of value to business people, e.g. sales representatives who do not wish to waste time away from their busy schedules to attend formal training events.

One of the form of using the mobile learnings concepts in classroom is the use of *podcasts*. ***Podcasting*** consists of listening to audio recordings of lectures. It can be used to review live lectures (Clark & Westcott 2007) and to provide opportunities for students to rehearse oral presentations. Podcasts may also provide supplemental information to enhance traditional lectures.

Work

M-learning in the context of work can embrace a variety of different forms of learning. It has been defined as the "processes of coming to know, and of being able to operate successfully in, and across, new and ever changing contexts, including learning for, at and through work, by means of mobile devices"

1. M-learning for work.
2. M-learning at and through work.
3. Cross-contextual m-learning.

M-learning for work, which could be also described as 'just-in-case' learning, involves classic and formal education activities, such as training courses, that prepare learners for future work-related tasks. A typical, corporate application is the delivery of mobile compliance training, which can be seen as a viable means to reach geographically mobile employees, such as consultants or staff in logistic and transport systems. Another

application is mobile simulations that prepare learners for future situations, for example real-time SMS-based simulations for disaster response training.

M-learning at and through work, which could be labelled as "just-in-time" mobile learning, occurs in informal education settings at the workplace. Employees can use the mobile phone to solve problems via handheld devices in situ, for example by accessing informational resources (such as checklists and reference guides) prior to customer visits or mobile decision support systems. The latter are popular in clinical settings where they support highly mobile medical staff through rule-based algorithms in the decision regarding more complex patient cases. Their application was associated with learning and in particular with practice improvement of medical staff.

Learning through work also occurs by interacting with distant peers via phone. "People tagging" is an approach whereby people assign topics they associate with co-workers. The aggregation of interests and experiences serves not only as a means to raise awareness but also to help find competent experts on demand, for example with context-sensitive expert location systems.

Cross-contextual m-learning that bridges the gap between work settings and formal education formats has perhaps the biggest potential for work-based mobile learning, specially with respect to tertiary education systems. This involves approaches in which learning in the workplace is facilitated and substantiated (for example through formative assessments, reflective questions or the documentation of personal achievements in multimedia learning diaries or portfolios).The so-created materials are later used in more formal educational formats, for example in the classroom or in the discussion with tutors. The value of these mobile phone-mediated learning practices lies in the integration and reconciliation of work-based learning and formal education experiences which otherwise tend to remain separated.

Self-learning

Mobile technologies and approaches, i.e. *mobile-assisted language learning* (*MALL*), are also used to assist in language learning. For instance handheld computers, cell phones, and podcasting (Horkoff & Kayes2008) have been used to help people acquire and develop language skills.

Mobile-assisted language learning (***MALL***) is language learning that is assisted or enhanced through the use of a handheld mobile device.

MALL is a subset of both Mobile Learning (m-learning) and ***computer-assisted language learning*** (***CALL***). MALL has evolved to support students' language learning with the increased use of mobile technologies such as mobile phones (cellphones), MP3 and MP4 players, PDAs and devices such as the iPhone or iPad. With MALL, students are able to access language learning materials and to communicate with their teachers and peers at any time, anywhere.

Others forms

There are other forms and possibilities to use the mobile learnings such as:

- Improving levels of literacy, numeracy, and participation in education amongst young adults.
- Using the communication features of a mobile phone as part of a larger learning activity, e.g. sending media or texts into a central portfolio, or exporting audio files from a learning platform to your phone.
- Developing workforce skills and readiness among youth and young adults.

4.2. The features of mobile learnings

Along with the development of m-learning, many theories about mobile educations are raised by researchers, such as:

- mobile learning is learning happens when technological tools mediates between the learner and knowledge,
- mobile learning uses mobile technology,
- mobile learning is a continuation of e-learning,
- mobile learning is learning about the learner-centered: where the learner is mobile and not necessarily technology.

Main characterization of m-learning can be given as follows:

- it can get access to information and educational experience faster than other media,
- it is supported by portable devices, its mobility makes it easy to use,
- comparing to other methods of learning, the cost of m-learning is relatively low.
- exchange of information can be encrypted or private,
- it is easy to access all kinds of information.

Tutors who have used m-learning programs and techniques have made the following value statements in favor of m-learning:

- It is important to bring new technology into the classroom.
- Devices used are more lightweight than books and PCs.
- Mobile learning can be used to diversify the types of learning activities students partake in (or a blended learning approach).
- Mobile learning supports the learning process rather than being integral to it.
- Mobile learning can be a useful add-on tool for students with special needs. However, for SMS and MMS this might be dependent on the students' specific disabilities or difficulties involved.
- Mobile learning can be used as a 'hook' to re-engage disaffected youth.

- M-Learning can be designed to combine decision making in complex learning scenarios with formative scoring and assessment.

Benefits of using the mobile learning are as follows:

- relatively inexpensive opportunities, as the cost of mobile devices are significantly less than PCs and laptops,
- multimedia content delivery and creation options,
- continuous and situated learning support,
- decrease in training costs,
- potentially a more rewarding learning experience,
- new opportunities for traditional educational institutions,
- readily available a/synchronous learning experience,
- decrease in textbook costs,
- access to personalized content,
- remote access to knowledge,
- improved literacy levels.

4.3. Conlusions

Mobile learning is widely used in schools, workplaces, museums, cities and rural areas around the world. In comparison to traditional classroom pedagogical approaches, mobile learning allows widened opportunies for timing, location, accessibility and context of learning.

Current areas of growth include:

- testing, surveys, job aids and just-in-time (J.I.T.) learning,
- location-based and contextual learning,
- social-networked mobile learning,
- mobile educational gaming,
- delivering m-learning to cellular phones using two way SMS messaging and voice-based CellCasting (podcasting to phones with interactive assessments),
- cloud computer file storage.

5. VIRTUAL AND AUGMENTED REALITY LEARNING

Virtual reality (***VR***) is a three-dimensional virtual environment that uses VR “goggles” or glasses to mimic reality as closely as possible. **Augmented reality** (***AR***), a related technology, enhances (or augments) reality by providing digital information on top of what the user is seeing, allowing learners to practice skills and understand the outcomes of their actions in a simulated environment. Both VR and AR are being explored as new

tools for training; what better way to train employees for reality than by imitating it in the virtual or in-person classroom?

Augmented Reality makes the real-life environment around us into a digital interface by putting virtual objects in real-time. AR uses the existing environment and overlays new information on the top of it unlike virtual reality, which creates a totally artificial environment. AR can be seen through a variety of experiences. Recent developments have made this technology accessible using a smartphone which led to development of wide varity of augmented reality applications.

Augmented Reality Applications are software applications which merge the digital visual (audio and other types also) content into the user's real-world environment. There are various uses of AR software like training, work and consumer applications in various industries including public safety, healthcare, tourism, gas and oil, and marketing.

5.1. Features of Virtual and Augmented reality

Virtual Reality immerses users in a virtual environment that is completely generated by a computer. The most advanced VR experiences even provide freedom of movement – users can move in a digital environment and hear sounds. Moreover, special hand controllers can be used to enhance VR experiences, and haptic peripherals can add enhancement and feedback to movements.

To experience virtual reality, special headsets are required. Most VR headsets are connected to a computer (Oculus Rift) or a gaming console (PlayStation VR) to harness computational power to enable high-fidelity experiences.

However, standalone devices such as Google Cardboard have become the most popular, especially given their low price point. Most standalone VR headsets work in combination with smartphones – we insert a smartphone into the headset and immediate enter the virtual world. This is slowly evolving to standalone, tetherless headsets that allow the user greater freedom of movement like the Oculus Quest.

In **augmented reality**, users see and interact with the real world while digital content is added to it. Here we can think of Pokémon Go – millions of people all over the world have been rushing with their smartphones in search for small virtual creatures. That's the most vivid example of augmented reality.

If we own a modern smartphone, we can easily download an AR application and try this technology. Alternatively, there are also special AR headsets, such as Google Glass, where digital content is displayed on a tiny screen in front of a user's eye.

Mixed reality – the most recent development, sitting on the reality-virtuality spectrum midway between AR and VR. Without getting too technical, it helps to examine the two broad definitions:

1. *Mixed reality that starts with the real world* – virtual objects are not just overlaid on the real world but can interact with it. In this case, a user remains in the real-world environment while digital content is added to it; moreover, a user can interact with virtual objects. For example how Skype is used on Microsoft HoloLens.
2. *Mixed reality that starts with the virtual world* – the digital environment is anchored to and replaces the real world. In this case, a user is fully immersed in the virtual environment while the real world is blocked out. In fact it does, but the digital objects overlap the real ones whereas in conventional VR the virtual environment isn't connected to the real world around a user. To experience this form of mixed reality, we can wear Windows mixed reality headsets.

5.2. Applications of Virtual and Augmented Reality

The first commercial application of AR technology was the yellow "first down" line that began appearing in televised football games in 1998. Some other popular examples of AR applications include AcrossAir, Google Sky Map, Layar, Lookator, SpotCrime, PokemonGo.

The most known examples of augmented reality applications with their impact on the future of mobile technology are as follows:

Augmented Reality in 3D viewers – this allows users to put life-size 3D models in their environment with or without the use of trackers. Trackers are the simple images that 3D models can be linked to in Augmented Reality. Examples: AUGMENT, Sun Seeker,

1. ***AUGMENT*** allows its users to see their products in 3D in a real-life environment and in real-time through tablets or smartphones to drive sales and improve user engagement.This application is available on both, iOS and Android platform. It can be used for Retail, E-Commerce, Architecture, and other purposes also. Augment allows retailers and manufacturers to connect with each other and thereby enable the online shoppers to experience the products sitting at home before buying. Customers can view the images in 3D by rotating them and viewing all the augmented content before deciding to buy. It has plenty of customers, companies such as Coca-Cola, Siemens, Nokia, Nestle, and Boeing are using this application.
2. ***Sun-Seeker*** is an AR application which provides a flat compass view and a 3D view showing the solar path, its hour intervals, its equinox, winter and summer solstice paths, sunrise and sunset times, twilight times, magic hours and also a

Map view showing solar direction for each daylight hour. The application runs on both Android and iOS.

Augmented Reality in browsers – the AR browsers can enhance users' camera display with contextual information. For example, when we point our smartphone at a *building, we can see its history or estimated value.* Examples: Argon4, AR Browser SDK.

1. ***Argon4*** – it is a fully-featured web browser that has the ability to display augmented reality content created with the argon.js Javascript framework. Argon4 browser is available on iTunes App Store and Google Play Store. It allows any 3D view of reality to be augmented. Argon4 is very much similar to a normal web browser that allows multiple pages to be loaded into different tabs but it handles the case of multiple AR apps in a special way.
2. ***AR browser SDK*** – it allows the users to add augmented reality geolocation view to the Android and or iOS application in less than 5 minutes. With user-friendly API (Application Programming Interface), it can be fully customized. It has the functions of the augmented reality browser: provides video support, adds and removes single POIs in real time, can run on any device, offers great performance and memory management, has an exceptionally light view, smooth and accurate movements, provides custom activities like SMS, call, email, video, social networks.

Augmented Reality Games – this type of software is probably the most common type of appliactions. They create mesmeric gaming experiences that use your actual surroundings. Examples: Pokémon Go, Parallel Kingdom, Temple Treasure Hunt, Real Strike, Zombie Go.

1. ***Pokemon Go*** – the most popular AR game which allows users to catch virtual Pokémon that are hidden throughout the map of the real world. It uses real locations to encourage players to far and wide in the real world to discover Pokemon. The game enables the players to search and catch more than a hundred species of Pokemon as they move in their surroundings. The application works on both Android and iOS.
2. ***Real Strike*** – it is a popular shooting AR game which is available only on iOS. The users get a real life shooting experience in this game and can record their fights and also create their own videos. There is a pool which has been polluted by nuclear waste and a group of pests is just around the corner so players have to stop them infecting the earth. Users use their phone to scan the mark.The game offers night and thermal vision goggles to get a clear view even in the evening to complete your mission.

Augmented Reality GPS – AR applications in smartphones generally include Global Positioning System (GPS) to spot the user's location and its compass to detect device

orientation. Examples: AR GPS Compass Map 3D, AR GPS Drive/Walk Navigation.

1. ***AR GPS Compass Map 3D*** – the applications shows 3D compass that gets fused with the camera image and shows your current location from GPS on a separate map with adjustable size. The application can only run on Android interface. The compass uses a very effective amalgamation and filtering algorithm to combine the values of the magnetic field sensor, the accelerometer, and the gyroscope to get the maximum accuracy and stability which is a different feature as compared to other applications. The users can define their own waypoints if they want. The application also allows the users to share their current location and the locations of their waypoints with their friends. It also features a 3D stereoscopic view of the compass and the camera image on devices which have LG's Real 3D technology.
2. ***AR GPS Drive/Walk Navigation*** – this application make use of the smartphone's GPS and camera to execute a car navigation system with an augmented reality-powered technology. It is easier and safer than the normal navigation system for the driver. This application is available only on Android. The application guides the drivers directly by the virtual path of the camera preview video which makes it easy for them to understand. The drivers do not need to map the map the path and the road while using this app. The driver can see the real-time camera preview navigation screen to get driving condition without hindering his safety.

5.3. Conclusions

Virtual and Augmented Reality in student Learning and Development can completely revolutionize the way teachers teach and students learn. With the help of AR and VR, students will learn interactively like never before. These new technologies are not limited to any specific age group of students.

Virtual Reality can entirely change the world of education. VR is going to be used in education starting from the first grade to college. Using VR headsets, students can see the immersive content of any subject. Moreover, a 360-degree view of any content gives a more realistic feel to the students as they find themselves, as a part of the virtual environment. Also, interaction with VR content helps them explore the subject with profound detail. When students are too involved in the virtual world, they cannot be distracted by the real world. It also improves their concentration power. VR provides students with a complete sensory experience through which they can virtually touch, see, and hear the content at the same time with help sensors.

Augmented Reality helps students get a better understanding and insights about the topic. Also, offering interactive experiences, the Augmented Reality keeps students excited and interested in new learning.

One of the most significant benefits of Augmented Reality in Learning and Development is that it does not require any investment regarding hardware. We can experience Augmented Reality using our smartphones or tablets. For example, Augmented Reality application development allows to place the smartphone camera in front of a textbook and see a 2D image turning into a 3D animation.

6. DIGITAL EDUCATION METHODS TO VOCATIONAL TRAINING – OVERVIEW FROM ITALY

6.1. Flipped Learning – national practical examples

Although the flipped classroom has its roots in U.S.A. institutes, it now finds space in all countries of the world as an innovative teaching tool; among these countries, Italy did not delay in expressing its interest in this innovative teaching method which aims to stimulate students for an increasingly specific and motivating training.

The "Giacomo Leopardi" school (Marche Region) is the first teaching context in which the phenomenon of teaching with the flipped classroom was inserted and documented (E. Ricci, Flipped Classroom: beyond the face-to-face lesson in the 2.0 era). Another striking example of the implementation of the flipped classroom in Italy is the case of the teacher Grazia Paladino, teacher of mathematical sciences at a secondary school in Sicily. This has literally overturned the way of teaching mathematics and science in his class, demonstrating with exciting results how effective and effective this new innovative method is.

https://ischool.startupitalia.eu/education-main/ischool-2/33220-20141016-ho-capovolto-i-miei-alunni-con-la-flipped-classroom-una-rivoluzione

6.2. Mobile Learning – national practical examples

Although Italy, if compared to the other European countries, is present on the international scene with deficient structures dedicated to online teaching, it shows its stubbornness and determination to improve itself and the teaching structure “tout autour”.

In fact, gradually, it has implemented its devices with different platforms that facilitate teachers and students in the provision of online teaching. Just think of the notable increase, on the national territory, of the telematic universities that have made their telematic and technological structure their strong point; in fact, their telematic platforms are teeming with video lessons, online tests, free tutoring consultancy as well as training exercises that make the university landscape accessible to all those unable to follow lessons with precise timing and with specific learning needs. Not least, the public school has the possibility to use telematic platforms for the provision of teaching, the exchange of content and user feedback. However, these dynamics are not regularly implemented as the main teaching method in Italy is the traditional standard method.

However, in times of crisis and emergency, the mentioned supports make it possible to continue teaching and to provide a school service that takes into account ministerial programs, checks, explanations and above all pupil feedback. The most used platforms in Italy, besides the best known Whatsapp and Skype, are Argo and Classrooms.

Serena Faloj, associate professor of aesthetics at the University of Pavia is among the first teachers to record her podcast:

https://www.repubblica.it/cronaca/2020/03/03/news/coronavirus_con_le_scuole_chiuse_le_lezioni_online_puntano_sulla_fantasia-250109056/

Following the teacher from Pavia, the Politecnico of Milano also provided teaching and gave the opportunity to take lessons, exams and even graduation sessions through mobile learning: **https://www.corriere.it/scuola/universita/cards/coronavirus-universita-didattica-online-lezioni-esami-lauree-solo-distanza/lezioni-tempo-covid-19_principale.shtml**

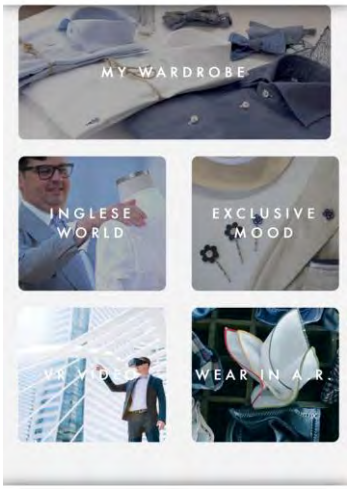
6.3. Virtual and Augmented Reality Learning – national practical examples

The G. Inglese company, a tailor shop in Ginosa (TA) always in step with innovation, has produced an innovative app that aims to be an exclusive virtual wardrobe for customers. This app has two very particular sections that relate to VR and AR: Wear in AR and VR video.

Wear in AR: in this section the user can try, through augmented reality, all the clutch bags and ties present in the clothing line of the tailoring; each item of clothing, associated with a marker (QRCODE), can be viewed and "virtually" worn simply by pointing the marker with the camera of your smartphone after having correctly positioned it.

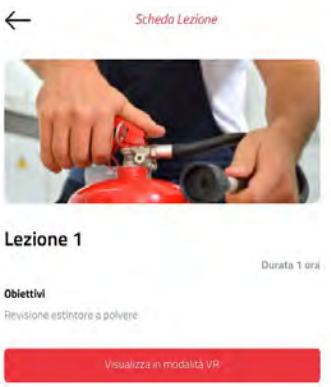
VR video: this section instead contains videos shot with a 360 ° camera; each video, which can be viewed with or without the aid of the viewer, allows you to experience the exclusivity of the production moments of the Ginosa company and the beauty of the breathtaking views of the Murgian city.

G. Inglese App:



L'Antincendio, a leading company in the sector of safety and firefighting systems based in Matera, has even produced an invention patent for VR and AR. The "Immersive VR Learning" App of L'Antincendio, subject of the invention patent, allows the user to carry out training for fire prevention and safety. Each course is made by one or more lessons with a final test quiz and in each lesson there are contributions in VR accessible through the viewer, which allow you to live the lesson in a real and immersive way. In the app there is also a section dedicated to AR, in which the user, by scanning the QRCODE associated with a specific device, is able to view all the information directly on his smartphone>

Antincendio Immersive VR Learning:



Another example of the application of VR is provided by Capurso trade & services, a leading company in the dairy products sector, based in Gioia del Colle (BA). the company has developed an anti-avoidance system with the help of virtual reality capable of understanding what the tastes of customers are; the interesting thing about this

system is that it is really able to understand which product the user is looking at at that moment through vr and how long it looks at it, thus determining the preferences of each user almost as if it were a survey, but in a very less invasive way.

7. DIGITAL EDUCATION METHODS TO VOCATIONAL TRAINING – OVERVIEW FROM POLAND

7.1. Flipped Learning – national practical examples

iFlip – method of flipped classroom in adult education, http://projectiflip.eu/, the EU project co-realised by Akademia Humanistyczno-Ekonomiczna w Lodzi.

The idea was to use the flipped method in the adult education, because this approach is particularly suitable to meet the needs of adult students because they can decide when to study and how to split their time. At the same time, it allows teachers in their class to adapt time to the individual needs of the student – by focusing on the basics of one and deepening the topic with others. It encourages and promotes the use of ICT, but with the support and guidance that adult learners need. Personal contact is ensured, but enough space and freedom is left for learners to design their own learning path. The FTC technique currently presents faster, more efficient and economical way of learning.

As part of this project:

- The needs of adult learners in partner countries were identified and Flip the Classroom (FTC) technique was presented to adult education teachers during the training.
- Teachers transferred the FTC technique to adult education, design classes and develop materials that meet the needs of adult learners; the pilot project were carried out in partner countries.
- After the pilotage, an assessment was made and feedback was provided. Additional changes were made according to feedback from adult learners. Trained teachers participated in events (national conferences) intended for other educators, service providers and decision makers, presenting the results of the research.
- The FTC-based learning manual for adult education was developed with a view to transferring the method and designing materials to other areas.

The flipped class method was introduced at the following courses in partner country: Company culture - is this a development problem, Increase group resources. How to work in a team?, Coping with stress

A week with an inverted class, https://etwinning.pl/tydzien-z-odwrocona-klasa/

The course is intended for teachers who are registered eTwinning users. The course is addressed to all teachers who want to use non-traditional models of conducting classes and introduce their results to international cooperation projects. The aim of the course is to familiarize with the reverse lesson method. After the training, the participant will be able to develop an inverted lesson plan in accordance with his curriculum, prepare tasks for all phases of an inverted lesson and develop interactive tasks.

MODERN project, http://www.modern.pm/

The MODERN project aims to help you teach more effectively through incorporating new digital learning tools into your day to day teaching delivery. MODERN aims to increase the ability and motivation of teachers, trainers and lecturers to use digital learning resources as a means to more effective, relevant teaching, thereby causing a positive impact in their students. The project has been funded by the European Commission under the ERASMUS+ Programme. MODERN seeks to generate greater acceptance of the mobile phone as a learning ally by upskilling trainers, teachers and lecturers in their knowledge of available tools and appropriate pedagogical strategies, so that they are confident in their ability to select and use appropriate mobile and digital resources in their everyday teaching activities.

Project partnership was formed by VET and HEI specialists, from across the profit, non-profit and public sectors: Canice Consulting, Universitat Politecnia de Valencia (Spain), University of Szczecin (Poland), Momentum Consulting, EUCEN European multidisciplinary Association, EfVET association.

7.2. Mobile Learning – national practical examples

Scholaris, http://www.scholaris.pl/

Scholaris is a knowledge portal for teachers that contains free educational materials tailored to all stages of education. Portal resources are compatible with interactive boards and other devices supporting the teacher's work, e.g. tablets.

The portal contains about 28 thousand individual, interactive materials that can be helpful in implementing content from all subjects, at various educational levels. These include: lesson plans, exercises, texts, animations, slides, simulations, didactic games, films. All Scholaris materials, regardless of their allocation to the previous or current core curriculum, can be helpful in the work of the student and the teacher.

EDUKATOR.PL, https://www.edukator.pl/

The educator platform is free, open educational tools and resources. We can use applications, simulators, models, readings, biological atlases, films and presentations available for free on the website – everything is in the platform's base. The richest collection of teaching tools and resources for free, but also ready resources, e.g. from biology or mathematics. On the platform, we can create presentations in which we

successfully place charts, mathematical formulas, chemical formulas, graphic elements, i.e. resources available on the platform.

POLONA, http://intro.polona.pl/

The POLONA digital library is the fastest way to use the resources in the National Library's magazines from today. Every day, employees make tens of thousands of scans and photos to make the collections fully available as soon as possible.

TEACHER – EDUCATIONAL PLATFORM, https://progmar.net.pl/pl/teacher-description

The System Teacher is an educational platform that serves as didactic support for primary, secondary and higher school students. The system allows:

- learning English (traditional tests, selection tests, puzzles, dictionary),
- learning Polish (dictation),
- learning mathematics (learning basic mathematical operations, drawing function graphs),
- science of chemistry (science of names and symbols of chemical elements, science of the periodic table),
- learning geography (learning the capitals of the world).

MATEMATYKA.PISZ.PL, http://matematyka.pisz.pl

Polish free educational platform on mathematics. It does not contain movies or presentations, but graphics enriched with a very concise text, perfectly explain the issues starting from the difference between numbers and numbers, and ending with integration and parts. A great "download" of formulas and basic rights allows you to vacuum the material before comprehensive exams, such as after junior high school or high school diploma.

7.3. Virtual and Augmented Reality Learning – national practical examples

Augmented Reality at School is an interdisciplinary project regarding educational activities on the border of mathematics and natural sciences and languages foreign, with particular emphasis on the use of modern information and communications technologies (ICT) as a communication tool, space for creating, acquiring knowledge and distance communication. This is our proposal that includes mobile technologies in school education. The potential of ICT is enormous and is of particular importance in stimulating the network cooperation, exchange of knowledge and implementation of innovative solutions.

Warsaw'44 – Traces of Memorials – Layar for the Warsaw Uprising Museum

The Adv.pl agency currently has LemonSky created an application for the Warsaw Uprising Museum called "Warsaw'44 – Following the Warsaw Uprising by mobile". This application allows you to learn about the history of Warsaw through the use of

innovative solutions in the field of AR. Thanks to it, both Warsaw residents and tourists visiting the capital has the opportunity to take a virtual journey through the historical places of memory. After using the geographical coordinates and the camera, the application overlays on the camera texts and photographs presenting all important places of the Warsaw Uprising. With the help of such solutions, users can find information about places that remember the history of those times in an attractive and innovative way.

8. DIGITAL EDUCATION METHODS TO VOCATIONAL TRAINING – OVERVIEW FROM PORTUGAL

8.1. Flipped Learning – national practical examples

The Portugal INCoDe.2030 Initiative is framed by the international context and aims at improving Portugal's positioning and competitiveness, pursuing the purpose of securing a prominent place in digital competences within the years 2017-2030.

The current positioning of Portugal in Europe, the challenges to be assumed, the quantification of the measures taken and the results achieved over time, as a result of this program, can be understood through a set of indicators divided into 5 categories (accessibility, human potential, usage, investment, and training and certification) in 5 axis: Inclusion, Qualification, Specialization, Research and Education. The General Directorate of Education (DGE) is responsible for the Education axis.

https://www.incode2030.gov.pt/

Future Classroom Lab (FCL): created by European Schoolnet, the Future Classroom Lab (FCL) is an inspirational learning environment in Brussels, challenging visitors to rethink the role of pedagogy, technology and design in their classrooms. Through six learning zones, visitors can explore the essential elements in delivering 21st century learning: students' and teachers' skills and roles, learning styles, learning environment design, current and emerging technology, and societal trends affecting education.

Since the opening of the Future Classroom Lab in January 2012, European Schoolnet and its 34 supporting Ministries of Education have worked closely with a growing number of ICT providers to ensure an independently funded and sustainable platform. Policymakers, industry partners, teachers and other education stakeholders regularly come together in face-to-face training workshops and strategic seminars to develop visions for the school of the future and strategies on how to realise these.

http://fcl.eun.org/

Learning Laboratories (LA): learning initiative is developed by the Directorate-General for Education, in partnership with the European Schoolnet (EUN), and consists

of the dissemination of methodologies for the curricular integration of ICT that have been validated in pilots of European scope.

In fulfilling its Mission, ERTE makes available, through the LA initiative, a set of tools, guidelines and resources that allow to support schools in the design, adaptation and implementation of innovative teaching and learning scenarios.

This initiative is an opportunity for schools to assert themselves, among others, as spaces for innovation, catalysts for collaborative work, the development of creativity, autonomy and critical thinking.

The activities of LA include, among others, the promotion of workshops, courses and training workshops and the holding of MOOCs whose main target audience are teachers and educators.

https://erte.dge.mec.pt/

EduScratch project: the main goal is to promote the use of Scratch in school environment. The platform provides schools and teachers with support, information regarding initiatives and events since 2010. Its development aims at disseminating and supporting the use of Scratch (and the knowledge about this tool), as well as encouraging its use through training and sharing.

http://eduscratch.dge.mec.pt/

The MENTEP Project (Technological Mentoring-Enhanced Pedagogy): mentep project has as its main goal the development and validation of an online tool, which allows teachers to know their level of proficiency in the use of ICT in the promotion of learning, thus allowing them to control the evolution of learning in this area and to identify training needs. MENTEP is a partnership of 13 countries: Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Greece, Italy, Lithuania, Norway, Portugal, Slovenia, Spain.

http://mentep.eun.org/

Educational Technologies and Resources Team: the educational resources and technologies area is, within the scope of this Directorate-General, the responsibility of the Educational Resources and Technologies Team (ERTE) whose main objectives are to propose ways and modalities for the integration of Information and Communication Technologies (ICT) in all levels of education and teaching as well as setting guidelines for use.

https://erte.dge.mec.pt/

Teachers TryScience initiative: this project is supported in Portugal by DGE, results from a collaborative effort between the New York Hall of Science, IBM Corporation and teachengineering.org. It constitutes a tool of work and complementarity for teachers in

the construction of the students' curricula, being transversal to several subjects and years of schooling. The official website suggests and makes available activities, supports, agendas, methodologies, objectives, quick discussions, examples of work adaptable and adjustable to different ages and needs, working as an incentive strategy and increasing skills in the areas of Science, Technology, Engineering and Mathematics, bringing the concept of project-based learning to classrooms. It also intends to serve as a source of professional development for teachers and students.

http://teacherstryscience.org/

Khan Academy website, now adapted to the Portuguese curricula, and made available by the Altice Foundation, Portugal's largest communication company. Since 2013, it offers free videos and interactive exercises available at any time of the day. Just have a computer with internet access! The contents can be used by anyone, students, teachers, Heads of Education, etc. With personalized teaching, this platform recognizes the knowledge that each student already has and suggests the knowledge that needs to be acquired. In addition, the teacher has immediate access to the performance of his students, being able to identify the difficulties of each one's difficulties. In addition to interactive videos and an exercise platform, the Altice Foundation also offers free workshops in schools, training teachers not only to use the platform on a day-to-day basis with their students, but also to share that knowledge with other educators.

https://pt-pt.khanacademy.org/

House of Sciences: funded by the Calouste Gulbenkian Foundation is a project that fosters the creation of digital learning resources by secondary school teachers through support from higher education teachers. The project maintains a large repository of digital learning resources (DLR) aims to increase STEM teaching and learning. In addition, there are several initiatives for the development of e-books, but these are local and have a rather narrow scope

https://www.casadasciencias.org/

8.2. Mobile Learning – national practical examples

The Portugal INCoDe.2030 Initiative is framed by the international context and aims at improving Portugal's positioning and competitiveness, pursuing the purpose of securing a prominent place in digital competences within the years 2017-2030.

The current positioning of Portugal in Europe, the challenges to be assumed, the quantification of the measures taken and the results achieved over time, as a result of this program, can be understood through a set of indicators divided into 5 categories (accessibility, human potential, usage, investment, and training and certification) in 5 axis: Inclusion, Qualification, Specialization, Research and Education. The General Directorate of Education (DGE) is responsible for the Education axis.

https://www.incode2030.gov.pt/

Educational Technologies and Resources Team: the educational resources and technologies area is, within the scope of this Directorate-General, the responsibility of the Educational Resources and Technologies Team (ERTE) whose main objectives are to propose ways and modalities for the integration of Information and Communication Technologies (ICT) in all levels of education and teaching as well as setting guidelines for use.

https://erte.dge.mec.pt/

Rural Needs & Mobile-Learning (Erasmus+): the main objective of the project is to test and validate a new learning approach (methodology), designed to meet the specific needs of employment and social inclusion detected in rural environments in the EU.

This methodology, as well as the Manual and Guide developed within the scope of the project, will be tested through a demonstrative pilot action, carried out in 4 geographical itineraries of the 4 participating countries (25 rural municipalities), with the support of a platform and -learning and a mobile classroom that will travel to each municipality.

http://www.fjuventude.pt/pt/1587/rural-needs--mobile-learning.aspx

Porto Editora: Runs the Virtual School portal where it sells multimedia products and maintains the largest collection of commercial interactive online resources for all subjects in the Portuguese curriculum.

https://www.portoeditora.pt/sobre-nos/e-learning

LeYa: one of the most important Portuguese textbook publishers, has developed Platform 20, a platform that provides access to learning resources such as digital textbooks, videos, animations, games and interactive tests.

https://www.leyaonline.com/pt/gca/links-uteis/download-apps/

8.3. Virtual and Augmented Reality Learning – national practical examples

The Portugal INCoDe.2030 Initiative is framed by the international context and aims at improving Portugal's positioning and competitiveness, pursuing the purpose of securing a prominent place in digital competences within the years 2017-2030.

The current positioning of Portugal in Europe, the challenges to be assumed, the quantification of the measures taken and the results achieved over time, as a result of this program, can be understood through a set of indicators divided into 5 categories (accessibility, human potential, usage, investment, and training and certification) in 5

axis: Inclusion, Qualification, Specialization, Research and Education. The General Directorate of Education (DGE) is responsible for the Education axis.

https://www.incode2030.gov.pt/

Educational Technologies and Resources Team

The educational resources and technologies area is, within the scope of this Directorate-General, the responsibility of the Educational Resources and Technologies Team (ERTE) whose main objectives are to propose ways and modalities for the integration of Information and Communication Technologies (ICT) in all levels of education and teaching as well as setting guidelines for use.

https://erte.dge.mec.pt/

Artificial Realities: Virtual as an Aesthetic Medium for Architectural Ideation'

Is an associated project of Lisbon Architecture Triennale 2019. It is an exhibition coupled with a one-day symposium hosted and organized by ISTAR Information Sciences, Technology and Architecture Research Center, ISCTE-IUL in Lisbon.

The project is framed by the confrontation between rationality and efficiency related to virtual technologies applied to the architectural design process.

http://istar.iscte-iul.pt/artificialrealities/

VR@School

Is a project creates a complete different classroom? VR@School is a ground-breaking project offering a student-teacher friendly interface, practical resources and guidelines, embedded educational resources and simple-to-use VR lessons designed to help raise engagement and increase knowledge retention for students.

https://www.vr-school.eu/

AR Association (VRARA)

Is an ecosystem that brings together people, start-ups and companies to create innovative solutions in virtual and augmented reality for business application. VRARA is considered the largest association of virtual and augmented reality, with 4,500 companies, brands and schools and over 29K professionals registered. Its function is to create guides for the best practices in the use of AR / VR technology. Its members come from all areas, not exclusively technological, to support the creation of value for the community, which include meetings between producers and technology enthusiasts.

University of Aveiro

Virtual Reality (VR) and Augmented Reality (AR) mainly allow a visual experience (but also multi-sensorial), through specific hardware as head-mounted displays and

interaction devices, or complex facilities as CAVEs (Cave Automatic Virtual Environments).

The courses aims at introducing students to basic concepts, methods and tools allowing the design and development of simple VR and AR systems.

https://www.ua.pt/en/uc/12023

Cognitive stimulation and virtual reality for the elderly

Portuguese organization Santa Casa de la Misericordia has decided to implement several products from the Kwido catalog to offer modern solutions to the general public. Specifically, our Kwido Mementia program has been chosen to perform cognitive stimulation online in up to 20 centers. In this way, we bet on a format of novel cognitive therapy, and with a high motivational com ponent for users.

https://www.kwido.com/cognitive-stimulation-vr-elderly-lisbon/

GILT research group

Is in the Engineering College (ISEP) of the Porto's Polytechnic Institute (IPP) and focuses on the analysis, design and development of scientific and technical knowledge in the fields of Serious Games, Assistive Technology, Learning Technology, Interaction and Health Technology.

GILT researchers promote the group's R&D mission linking it to post-graduate programmes at MSc and PhD level and leading international collaborative projects and joint initiatives with other academic and commercial institutions

http://gilt.isep.ipp.pt

I SEA Project – Virtual Reality Experience

The UT Austin Portugal Program invites you to participate in a virtual reality experience, developed within the scope of the I SEA project, an exploratory research project financed by FCT in the frame of our 2017 Exploratory Research Projects Call.

In this experience, you can go on a virtual expedition to the deep sea of the Azores, get to know its ecosystems, make decisions and complete missions.

https://utaustinportugal.org/events/i-sea-project-virtual-reality-experience/

9. DIGITAL EDUCATION METHODS TO VOCATIONAL TRAINING – OVERVIEW FROM SLOVENIA

9.1. Flipped Learning – national practical examples

Biotechnical school Maribor: Context: FC used in class of secondary school, subject Anatomy with physiology, lesson on Immune response

General setting: The immune response is a good example of the flipped learning where the teacher motivates students by involving them in the selection of themes for which he/she then prepares a video clip. The added value is exceptional. Topic is extensive and for future veterinary technicians very important, it can include several books. Here it is presented in 30 minutes long very illustrative video. Video imitates teacher drawing on the blackboard with coloured chalk while explaining. Students can watch videos anywhere and repeatedly. This method of work allows teachers save valuable time in the classroom to consolidate students and build on their knowledge in a creative way. After they watch a video at home, they need to draw a comic in the classroom using only pictures and no words to recreate the knowledge they have gained.

Free description: By drawing comics, students create associations, which help them to memorize relevant facts more easily. By explaining the topic to their classmates, they learn quickly and efficiently, and they verify, repeat and consolidate their knowledge and receive new associations, while training their communication skills. Effective and useful application of information and communication technology to facilitate learning allows more time to achieve higher taxonomic levels and individualization and enhances the development of creativity. Feedback was positive, students got inspired and creative. Teacher evaluates the method as useful as it encourages students to build their own knowledge and reflect on the topic. The use of ICT is appropriate, but it takes a certain amount of teachers' time and engagement. As the teacher creates videos according to students' choice this gives them a feeling of contributing to the teaching.

Technology used: http://www.smoothdraw.com, http://www.techsmith.com/camtasia.html

http://www.inovativna-sola.si/component/k2/item/453-kako-bi-flipnil-pouk

iFlip project (Erasmus+), Coordinating partner Andragoski zavod Ljudska univerza Velenje-LUV (Velenje, Slovenia) www.lu-velenje.si. iFlip course for teachers and trainers: http://xerte.zorgopleiden.nl/play.php?template_id=40

The LUV's teachers have prepared 4 courses for the purpose of the project, as follows: Pilot SI-01: **Glagoli v italijanskem jeziku | Verbs in Italian** Pilot SI-02: **Barbarina učilnica slovenščine | Barbara's classroom of Slovene** Pilot SI-03: **iFlip English Class | Present Perfect vs. Simple Past** Pilot SI-04: **Izbor podatkov v Excelu in Spajanje dokumentov | Selection of data in Excel, Merging documents**

Evet2edu (Lifelong Learning Programme, Action Leonardo Da Vinci – Transfer of Innovation; 2012-2014)

The purpose of the project was to assist teachers and mentors in vocational schools in the introduction of dynamic, open and innovative methods by adapting e-learning to vocational education. The e-course is based on innovative pedagogical

methods (for example, online collaboration, reflections, peer learning) and the use of various open source tools. The project offered knowledge that enabled teachers and institutions to integrate these tools into new qualifications frameworks and current teaching methods. The course is freely available in 9 languages along with a comprehensive guide.

https://evet2edu.cel.agh.edu.pl/moodle/index.html

University of Maribor (The Faculty of Natural sciences and Mathematics). Course Powerpoint presentation: **https://lej.si/7l**

9.2. Mobile Learning – national practical examples

Pedagogy 1:1 in the light of 21st century competences (2011-14): the project aimed at improvement of the 21st century competences (critical thinking, creativity, problem solving, etc.), improvement of teaching and learning supported by mobile devices (tablets) used by learners and development of a new learner-centered culture supported by technology (flexibility, personalization, combining different learning styles) with the focus on inclusion of socially disadvantaged groups.

Project innovative pedagogy 1:1: the project Innovative Learning Environments supported by ICT – Innovative Pedagogy 1:1 connects and upgrades the results of previous projects to modernise teaching and learning in Slovenia, like E-education, Pedagogy 1:1 in the light of the 21st century competences, E-school bag and ATS 2020. The project (further) develops technology-rich innovative learning environments enabling implementation of innovative pedagogy 1:1 for personalized and cooperative learning and formal assessment. Mobile devices are used to support many different learning strategies; introducing elements of formal assessment and considering the development of new competences gained when learning with technology. The employment of modern technology in education does not mean the use of technology in teaching only, but implies the integration of technology into pedagogical and organizational processes, technical aspects and contents.

The project consortium is coordinated by the Institution of Anton Martin Slomšek and consists of 4 research and development institutions as well as 75 schools and school centres (including VET), cooperating as development or implementation institutions. There are groups of experts for development and operating in 11 areas: pedagogical strategies upgrade, methodologies upgrade, teachers and headmasters training, expert e-communities, examples of good use, implementation curricula, implementation, technical area, testing and introducing didactic e-services, evaluation and promotion.

SKILLCO – An innovative project for facing skills gaps in the construction industry (ERASMUS+, Sector Skills Alliance, 11/2016 – 01/2020).

The app »SkillgApp« is a sectoral mobile app, which can be used as a supporting training tool for trainees in VET schools, adult workers-employees or unemployed

construction workers as innovative learning pathway-powerful and modern didactical mean.

Videos, handbooks, quizzes, assessment papers and further learning material give the user an extensive insight in four selected skill gaps. Furthermore there are videos for valuable key vanishing skills.

The app is prepared as an open educational resource (OER) which gives users the possibility to upload papers, pictures and so on. Those contents will be available in the app after a short reviewing process.

Not least because of that the app will enable VET lecturers to fill their lessons with high quality sectoral EQF levels specific skills materials.

Virtual reality (VR) and augmented reality (AR) are becoming increasingly important in the education process, which is also recognized by SKILLCO project partners. To this end, we developed the 3D model of the Skillco house to assist in the planning of building and reading plans. With the help of VR glasses, students can see the exterior of the house and walk through its interior.

3D Skillco house is now freely accessible on this web page: https://www.skillco.eu/en/content/outputs/ under working package #3.

Mission CŠOD: at the Centre for school and Outdoor Education (CŠOD), they developed an application for mobile devices Mission CŠOD, which in an innovative way enables independent experiential learning on educational trails in the surroundings of CŠOD homes. The application is based on the concept of game-fiction, which adds to the learning process elements of games and further motivates users to achieve learning outcomes. It has achieved excellent results for students attending CSW homes. With the training of primary and secondary school teachers, they were extended to general education. An interactive e-learning module in the online classroom is also available. The entry system is one-on-one and even students at school can create "missions" (learning adventures). There are already over 60 learning adventures covering interesting locations throughout Slovenia (CŠOD, 2019).

The demo video is available on Youtube CSOD Mission: https://www.youtube.com/watch?v=1oC11Dhv1Ew

9.3. Virtual and Augmented Reality Learning – national practical examples

School Centre Nova Gorica: the LFL (Learning Fabrication Laboratories) at Nova Gorica School Centre was opened in 2017. It is located in the Centre's Intercompany Training Centre and is open to everyone. It is designed as an open space for the primary school students, upper secondary students, higher vocational students, teachers, business representatives and interested individuals to explore and implement their ideas.

All devices (cycle lathe (CNC and handheld), milling machines, 3D printers, laser, electric hand tools, soldering irons…) and materials are available at FLF, also for renting out. Students come on a voluntary basis, also for the purpose of matura exam projects

or diploma work, sometimes they go to LFL at the initiative of teachers. In 2018, an enthusiastic higher VET school graduate has been employed to coordinate the work in LFL, including among company trainers and students. He also provides support to young people with LFL tasks, promotes LFL among companies (eg. organizes company site visits so that they can see what could be prototyped in it). Together with the Regional Development Agency, he organizes mobile lab visits to primary schools. He runs the so called “interest activities”, where the students can prototype their ideas.

Various events are organized at the LFL: free of charge workshop for students (AR / VR workshop, where young people learned and tested AR / VR technology and created and tested their own application in the Unity programming environment), treasure hunting with the help of modern technologies, 3D printers workshops ... Arduino holiday workshops were organized for primary school students. They also plan workshops with the Technology Park and make arrangements with the companies to present their new technologies.

Pattern City Velenje: the ecosystem for education, experimentation, prototyping, R&D and innovation... This unique, interactive environment is focused on providing interdisciplinary content with learning by doing and playful learning methodologies. Pattern City functions as a Smart City stakeholder’s knowledge intersection and innovation generator. Their purpose is co-creating environment which is inclusive, innovative and reflective, where learning experience is discovering patterns through storytelling and citizens are able to experiment on real life scenarios.

10. DIGITAL EDUCATION METHODS TO VOCATIONAL TRAINING – OVERVIEW FROM SPAIN

10.1. Flipped Learning – national practical examples

Fundación Bias: this non-profit institution is responsible for supporting educational establishments in their digitisation in different areas in order to respond to current demands, developing innovation and transformation programmes.

The Foundation carries out an analysis of each school and helps to create models of unique pedagogical projects based on the values that each school defends, adapting to the Flipped Learning pedagogical model and its various methodologies.

The Bias Foundation works together with the MT Group and Digital Competence, carrying out an analysis of the digital competences of the validated center around the common framework of them. This way the support service is optimal and specialized.

https://www.fundacionbias.org/

Grupo MT: it is a group of entities specialized in the education sector that offers the educational centres their advisory services and accompaniment in the methodological changes of the centre, which aim to develop open training, integral and innovative aimed at the whole educational community.

Using the most advanced technology and agile methods, they respond with complete and efficient management, betting on innovation in the classrooms.

https://www.mtgrupo.com/

Escuela Excelente – AMICE: the Association for the Improvement, Innovation and Quality of Education has established the Excellent School programme, which promotes the technical, professional and financial improvement of educational establishments. Convinced that the new education must be driven by the main agents of change, teachers promote inter-school collaboration in a common space such as the Association. In addition, they organize annually the Profess Excelentes days, which are held during the month of June in Aranjuez (Madrid, Spain) and during which more than 300 teachers meet to share their experiences through interesting presentations and collaborative work on different innovative methodologies such as Flipped Learning.

http://escuelaexcelente.es/

Colegio San Gabriel: this school located in Zuera (Aragon, Spain) has pioneered the implementation of Flipped Leraning since 2014. Understanding the essence of this methodology, they have applied it to the Institution in such a way that each student is provided with the educational opportunities he needs to develop successfully. They use ICT as tools and base their way of working on collaborative, problem-based project work, etc. With great success, this school gets its students to strengthen the educational concepts necessary for them to acquire the skills that allow them to face the future, with the help of the teacher and with the use of the latest educational technology.

https://sangabriel.es/

Universidad de Granada: at the University of Granada (Andalusia, Spain), the Flipped Learning methodology was implemented for the Degree in Industrial Electronics Engineering and Engineering in Telecommunication Technologies, using ICT tools, video classes, self-assessment questionnaires and discussion forums. Although the implementation of the method proved difficult for both the student and the teaching staff, the conclusions drawn by the University are positive in guiding teaching.

https://www.ugr.es/

10.2. Mobile Learning – national practical examples

Proyecto ENLACE: with the participation of the following entities: UNED, University of Malaga, SEO Birdlife, Instituto de Educación Secundaria Diego Velázquez, the aim of the

project is to explore the design of innovative educational environments, providing intelligent support for a wide range of learning activities in domains related to nature sciences. They want to share knowledge in a social structure of "learning communities". To this end, they design open computing environments that integrate modelling tools for collaborative solution analysis and construction, offering semantic mechanisms for storing, sharing and exchanging data/multimedia objects/artifacts, facilitate mediation and negotiation in order to propose, organize and carry out collaborative tasks, which dynamically respond to the needs of the different modes and situations of work and individual or collective experimentation, in the classroom, in the laboratory, in nature, offering flexibility to design and carry out activities that are adapted to the needs of each group.

http://enlace.uned.es/descripcion/index_es.html

Mobile Learning EOI: this project aims to experiment with the connectivity, ubiquity and multimedia production capabilities that enable state-of-the-art mobile devices such as smartphones and tablets. Since 2009, EOI (School of Industrial Organization) students have had a mobile device to harness their potential as a learning and networking tool. In this way, both teachers and students share educational resources and communicate with each other at all times and from anywhere.

https://www.eoi.es/blogs/mlearning/m-learning-eoi/

EDI – Educación Digital e Innovación: the research group of the Universidad Autónoma de Madrid works around three main pillars:

- To know the techno-pedagogical elements that originate the good use of technologies in education and training.
- Design innovative educational spaces with the support of digital technologies.
- Develop innovative research on digital educational resources and their associated methodologies.

And it integrates the use of mobile devices for all types of teaching activities.

http://edumovil.es/dim/?s=edumovil

Picaa – Universidad de Granada: the main contributions that Picaa offers are that it allows to adapt the user interface and the educational context to the needs and abilities of the student, offering an individualized teaching and supporting the realization of activities in group.

It allows the educator to design the activities and configure the system on the go, on the device itself. It also encourages cooperative work, which helps students learn behavioural norms, tolerate peers and educators, or make decisions. For students with special educational needs can help improve communication and integration in their environment.

http://asistic.ugr.es/picaa/

10.3. Virtual and Augmented Reality Learning – national practical examples

royecto Enreda: through UNED (University of Distance Education) this initiative was created that used Augmented Reality to get to know Madrid with activities and exploration games. More than a thousand young people participated in a gymkana in which they discovered the Spanish capital in the 17th century with the help of new technologies. In addition, as a conclusion to the activity, all participants had to create a blog or "travel notebook" and reflect everything they had experienced and learned in both the face-to-face and the virtual part.

http://www.ieec.uned.es/Investigacion/archivos/informe%20Enreda.pdf

Europa en la Maleta: the Mare Nostrum School in Ceuta has developed a project, "Europe in a suitcase", carried out by primary school students through augmented reality and other technological resources.

The project consists of three parts: a map of the city of Ceuta using BIDI codes linking to informative videos, an augmented reality puzzle with the map of Europe that can be worked from computers and mobile devices and a series of tokens from countries in Europe and, more in detail, from Ceuta, where representative monuments appear which, through an augmented reality program, you can see them on your computer in 3D.

https://www.ceutaactualidad.com/articulo/educacion/mare-nostrum-mete-europa-maleta-celebracion-simo-educacion/20151027125832015420.html

GOSCOS Project: the students of Basic Vocational Training of the Centro Salesianos Los Boscos (Logroño, Spain) of Electricity and Electronics and Informatics and Communications created the GOSCOS project, focused on gamification and learning. Within this project that integrates technology and syllabus of the disciplines studied, the augmented reality was integrated in the center.

https://thegoscos.wordpress.com/

Anatomy and Human Physiology – UNED: from the Vice-rectory of Research of the UNED (State University in Distance) through the Observatory of Technology in Distance Education carried out a pilot project dedicated to the incorporation of elements of augmented reality (two three-dimensional images and a video) in the teaching unit Anatomy and human physiology I in the anatomical planes, the bones of the skull and the sense of sight, corresponding to a subject bearing the same name. The application of augmented reality to carry out the project was Aurasma.

https://observatoriotecedu.uned.ac.cr/

Aula 3D – El Pinar School: at El Pinar School in Alhaurín de la Torre (Andalusia, Spain), a 3D classroom has been created in which students can study and design curricula through virtual and augmented reality.

https://www.colegioelpinar.com/

11.CONSLUSIONS

Immersive technologies are becoming more popular and accessible to consumers, and this means that we are starting to see their use in a wider variety of settings, including the classroom. When immersive technologies and game-based learning are deployed correctly and in a pedagogically consistent manner, they have the potential to support and expand curriculum, enhancing learning outcomes in ways which haven't been previously possible, affordable, or scalable.

Immersive technologies offer a broad range of tangible benefits for educators, not only in terms of student engagement, but also in the efficiency of delivery and retention of materials. These technologies' capabilities to engage and foster empathetic connections in students offer unique possibilities for teachers, who should be fully supported in exploring the pedagogical opportunities they afford, as the ability to anchor abstract knowledge within personalized experiences that elicit empathy towards others is an extremely valuable tool in preparing students for future challenges, they are likely to face. By encouraging and enabling students to not only view, but actively experience a variety of simulations and scenarios from different perspectives, teachers can help them build better social emotional skills, creating much more inclusive learning environments in the process.

In order to maximize the positive long-term impact of immersive learning experiences, however, we should not use such virtual environments to present isolated moments that provide short-term engagement or fragmentary insight. Instead, extended experiences that immerse students in rich contexts with strong narratives, authentic practices, and links to real-world outcomes are what truly unleash the transformational power of immersive and game-based learning experiences.

The consensus that emerges among those interviewed for this study is that immersive technologies – like all technologies adopted within a pedagogical classroom setting – should remain supplementary to in-person academic programming, allowing for human relations and interactions to ultimately guide the socialemotional learning experience. Quality teaching from consistent and well-resourced teachers is still the best tool in education, yet these technologies offer exciting possibilities in extending and democratizing the reach and impact of passionate, knowledgeable, and creative educators.

In Slovenia, the E-school project (2008-2013), which trained teachers and other professional workers in VET for a comprehensive acquisition of the pedagogical digital competences, enabled a major leap in this field. At the same time, top down courses were facilitated (seminars and other forms where the work programme was mostly already prepared), as were bottom-up workshops (for e-competent school leaders, pedagogical digital competences and other forms in the schools or in the local school environment). E-materials for general subjects and non-VET professional subjects were being developed systematically (including higher education).

National Education Institute prepared the iEcosystem portal to support the professional development of educators, teachers and principals in the field of the pedagogical digital competences as well as translated digital frameworks and self-evaluation questionnaire to Slovenian language to encourage all schools to upgrade the quality of digital education: DigComp 2.1, DigCompEdu, DigCompEdu self-reflection questionnaire, SELFIE self-evaluation questionnaire as well as TET-SAT self-evaluation questionnaire. After 2015, development projects (two of them; Project NA-MA-POTI, Project Innovative pedagogy 1:1) have continued and by 2022 a more integrated approach in a particular VET schools, that will include even more VET professional workers are foreseen. These projects address and develop the pedagogical digital competences of employees in VET and the digital competences of students as one of the transversal competences, so the e-competence is not in central focus. Consequently, the challenges of digital competences are considerable. Besides, there are many teachers and other professional workers in the new projects that have not been involved in the previous projects (2009-15). This means that the gap between those schools that were included in the previous projects and regularly update their digital competences (teachers and students), and those who were not, is increasing. At the same time, e-teams at schools, responsible for an annual analysis of the situation and planning improvements for the further ICT development of the school, are no longer active.

The national projects are not the sole reason for the widening gap. E-competent VET schools cooperate in local, regional, national, EU and other projects to develop and implement new teaching and learning approaches from technology-rich educational environments (digital evaluation, development e-portfolio, collecting, processing and use of learning analytics – learning analytics and the increasing use of AI in education). Thus, they are even more ahead of their peers.

The challenge in Slovenia is also the inclusion of the basic knowledge of computer science and informatics (e.g. in the context of computational thinking) in the regular curricula. Here VET is of great importance as there is a big need in the European labour market for the digital competences, and most countries have already introduced compulsory subjects in this field for all learners. Because of the centralised education system, these processes are slower in Slovenia than in educational systems, where the autonomy culture of a particular school and teacher is actually guaranteed.

Based on the results of the international largescale assessment (TALIS 2018; 2nd survey on ICT Education in Europe as well as MENTEP survey), the level of the introduction of ICT in lessons has dropped down since 2016. As an intervention, the new project on digital education 2020 – 2022 are in preparation to:

- support school in upgrade of digital school strategies and its implementation (usage of SELFIE tool as a starting point)
- encourage teachers to self-assess their pedagogical digital competences and upgrade use of ICT in classrooms
- encourage schools to systematically and vertically introduce assessment of digital competences of students (based on DigComp 2.1) and develop new curriculum of computational thinking / basic knowledge of computer science.

To take into account above mentioned it is clear that the results from the project DIGITAL TEACHING IN VET SYSTEM will help to foster digitalisation of educational system further on national level as well as international.

The digital transformation has now reached the education and training system, although there is still a long way to go in implementing it. This path must be based on a transformation of teaching methodologies used by teachers, since it is not enough to introduce new technologies in the service of traditional teaching models.

It is essential that new educational models seek to give pupils a leading role in their learning, while the teacher must act as a guide and companion on the path of education. For its part, digital tools, materials and resources must become not the focus of education (which would deprive it of content) but support for it and for the achievement of its objectives, expanding information and promoting more interactive educational subjects.

In Spain, we have several examples of educational entities that have opted to integrate new technologies into their curricula and the efforts made by educators are showing very positive results. In general, there is an increase in student motivation and performance, greater acquisition of skills related to teamwork, greater depth in content, higher performance, responsibility and time management, as well as more meaningful learning.

However, there are also some limitations such as the need for more extensive training of teachers in new technologies, the need for a high budget for the use of some technological tools or the extra effort that teachers should be willing to put into the education of their pupils, because attention, feedback and interaction must be individualized and personalized for each of them.

In any case, we can say that the inclusion of new technologies in teaching promotes the learning process of students and improves the quality of the subjects offered, as well as increasing participation and motivation in the classroom. That is why

today the approach of new technological tools to teaching appears as a necessity for the advancement of the educational system, which will result in an optimal education for the students who will have to develop in the society of the 21st century.

12.REFERENCES

7 Unique Flipped Classroom Models — Which is Right for You? Retrieved 25. 1. 2016 from http://panopto.com/blog/7-unique-flipped-classroom-models-right/

Abeysekera, Lakmal, and Phillip Dawson (2015). "Motivation and cognitive load in the flipped classroom: definition, rationale and a call for research." Higher Education Research & Development 34(1), 1-14.

Bergmann, J., & Sams, A. (2012). Flip your classroom: reach every student in every class every day. Washington, DC: International Society for Technology in Education.

Bloom, B. (1956). *Taxonomy of Educational Objectives: The Classification of Educational Goals*. New York: McKay.

Bonwell, C. C., & Eison, J. A. (1991). *Active learning: Creating excitement in the classroom (ASHE–ERIC Higher Education Rep. No. 1).* Washington, DC: The George Washington University, School of Education and Human Development.

Brame, C. J. (2013). Flipping the Classroom. Center for Teaching, Vanderbilt University. Retrieved from http://cft.vanderbilt.edu/teaching-guides/teaching-activities/flipping-the-classroom/

Greg Topp (6 Oct 2011), "Flipped classrooms take advantage of technology", USA Today

Hamdan, N., Patrick McKnight, P., McKnight, K. and Kari M. Arfstrom (2013). A Review of Flipped Learning. Flipped Learning Network. Retrieved from http://www.flippedlearning.org/cms/lib07/VA01923112/Centricity/Domain/41/LitReview_FlippedLearning.pdf

Honeycutt, Barbi & Garrett, Jennifer (2014), *"Expanding the Definition of a Flipped Learning Environment".* Blended and Flipped: Exploring New Models for Effective Teaching & Learning: Faculty focus.

Lents, N., & Cifuentes, O. (2009). *Web-based learning enhancements: Video lectures through voice-over PowerPoint* in a Majors-level Biology course. Journal of College Science Teaching, 39(2), 38-46.

Marco Ronchetti (June 2010), "Using video lectures to make teaching more interactive", International Journal of Emerging Technologies in Learning (iJET)

Nielsen, L. (2012). Five reasons I'm not flipping over the flipped classroom. Retrieved from http://theinnovativeeducator.blogspot.ca/2011/10/five-reasons-im-not-flipping-over.html

Ryback, D., & Sanders, J. (1980). Humanistic versus traditional teaching styles and student satisfaction. Journal of Humanistic Psychology, 20(87), 87-90

Strayer, J. F. (2012). *How learning in an inverted classroom influences cooperation, innovation and task orientation.* Learning Environments Research, 15(2), 171-193. doi:10.1007/s10984-012-9108-4

User Generated Education – The Flipped Classroom Model: A Full Picture. Retrieved from: https://usergeneratededucation.wordpress.com/2011/06/13/the-flipped-classroom-model-a-full-picture/

Bransford, J., Vye, N., Stevens, R., Kuhl, P., Schwartz, D., Bell, P., … Sabelli, N. (2006). Learning theories and education: Toward a decade of synergy. In P. A. Alexander & P. H. Winne (Eds.), *Handbook of educational psychology* (2nd ed., pp. 209–244). Mahwah, NJ: Lawrence Elerbaum Associates.

Sharples, M., Arnedillo-Sanchez, I., Milrad, M., & Vavoula, G. (2009). Mobile learning: Small devices, big issues. In N. Balacheff, S. Ludvigsen, T. Jong, A. Lazonder, & S. Barnes (Eds.), *Technology-enhanced learning* (pp. 233-249). Dordrecht: Springer Netherlands. doi:10.1007/978-1-4020-9827-7

Crompton, H. (2013). "A historical overview of mobile learning: Toward learner-centered education". In Z. L. Berge & L. Y. Muilenburg (Eds.), *Handbook of mobile learning* (pp. 3–14). Florence, KY: Routledge.

Trentin G. & Repetto M. (Eds) (2013). *Using Network and Mobile Technology to Bridge Formal and Informal Learning*, Woodhead/Chandos Publishing Limited, Cambridge, UK, ISBN 978-1-84334-699-9

Fombona, Javier; Pascual-Sevillana, Ángeles; González-Videgaray, MariCarmen (2017). "M-learning and Augmented Reality: A Review of the Scientific Literature on the WoS Repository". Comunicar (in Spanish). 25 (52): 63–72. doi:10.3916/c52-2017-06. ISSN 1134-3478

Cochrane, Thomas (2013). A Summary and Critique of M-Learning Research and Practice. ISBN 9780415503693.

Pachler, N., Pimmer, C., & Seipold, J. (Eds.). (2011). Work-Based Mobile Learning. Concepts and Cases. Oxford, Bern, Berlin, Bruxelles, Frankfurt am Main, New York, Wien: Peter-Lang, drawing on Pachler, N., Bachmair, B., & Cook, J. (2010). Mobile Learning: Structures, Agency, Practices (Vol. 1). New York, Dordrecht, Heidelberg, London: Springer.

Stead, G., & Good, M. (2011). "Mobile learning in vocational settings: lessons from the E-Ten BLOOM project". In N. Pachler, C. Pimmer, & J. Seipold (Eds.), Work-based mobile learning: concepts and cases. Oxford, Bern, Berlin, Bruxelles, Frankfurt am Main, New York, Wien: Peter-Lang

Coulby, C., Hennessey, S., Davies, N. & Fuller, R. (2009). "The use of mobile technology for work-based assessment: the student experience". British Journal of Educational Technology, 42, 251-265.

Zainuddin and Halili, Flipped Classroom Research and Trends from Different Fields of Study, April 2016.

FLIPPED LEARNING: PRACTITIONER GUIDE, National Foundation for Educational Research (NFER) and Nesta.

Flipping the classroom. Center for Teaching and Learning – University of Washington.

CCL GUIDE: LEARNING STORY FLIPPED CLASSSROOM. What is the Flipped Classroom model, and how to use it?. University of Minho, Portugal.

Flipped Higher Education Classroom: An Application in Environmental Education Course in Primary Education.

Evrim Baran, A Review of Research on Mobile Learning in Teacher Education. Middle East Technical University, Faculty of Education, Department of Educational Sciences Ankara, Turkey.

J. Bergmann, A. Sams, Flip your classroom: reach every student in every class every day, International Society for Technology in Education, Waszyngton 2012.

J. Dirksen, Projektowanie metod dydaktycznych. Efektywna strategia edukacyjna, Gliwice 2017. J. Bishop, M. Verleger, *The flipped classroom: A survey of the research*, ASEE National Conference Proceedings, Vol. 30. No. 9., Atlanta 2013.

S. Khan, Akademia Khana, *Szkoła bez granic*, Media Rodzina, Poznań 2013.

C. Rotellar, J. Cain, Research, P*erspectives, and Recommendations on Implementing the Flipped Classroom*, American Journal of Pharmaceutical Education, 80(2), 34/2016.

Raport o stanie edukacji 2012, *Liczą się efekty, praca zbiorowa,* Instytut Badań Edukacyjnych, Warszawa 2013.

R. Azuma, *Tracking Requirements for Augmented Reality*, „Communications of the ACM" 1993, nr 36 (7).

R. Boulic, R. Mas, *Hierarchical Kinematics Behaviors for Complex Articulated Figures*, [w:] *Interactive Computer Animation*, Prentice Hall, 1996.

J. Hensley, T. Scheuermann, G. Coombe, A. Lastra, M. Singh, *Fast summed-area table generation and its applications. Technical report*, University of North Carolina at Chapel Hill and ATI Research, 2005.

L. Lei i in., *ERT-VR: an immersive virtual reality system for emergency rescue training*, „Virtual Reality" 2005, t. 8.

B. Strug, *Modele oświetlenia*, Uniwersytet Jagielloński, Kraków 2004.

P. Supan, I. Stuppacher, *Image Based Lighting in Augmented Reality. Central European Seminar on Computer Graphics for students*, Wiedeń 2006.

Meirinhos, M., & Osório, A. (2011). O advento das TIC na escola como organização que aprende: a relevância. In V. Gonçalves, M. Meirinho, A. Muñoz-Repiso & F. Telejor (Eds.), Actas da Conferência Ibérica Inovação na educação com TIC 2011, pp. 39-54.

Carretero S.; Vuorikari R.; Punie Y. (2017). DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use. Luxembourg: Publications Office. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC106281/web-digcomp2.1pdf_(online).pdf

Government of the Republic of Slovenia (2006a). Action Plan for Further Leap of Informatization of Education. http://www.mizs.gov.si/fileadmin/mizs.gov.si/pageuploads/podrocje/IKT/akcijski_nacrt_informatizacija_solstva_8_2006.pdf

Government of the Republic of Slovenia (2006b). Slovenian National E-learning Strategy, 2006 – 2010, E-learning: Leading the Field. http://profesor.gess.si/marjana.pograjc/%C4%8Dlanki_VIVID/Arhiv2006/Papers/DELKokalj2006.pdf

Government of the Republic of Slovenia (2016a). Digital Slovenia 2020 – Development Strategy for the Information Society until 2020. http://www.mju.gov.si/fileadmin/mju.gov.si/pageuploads/DID/Informacijska_druzba/pdf/DSI_2020_3-2016_pic1.pdf

Government of the Republic of Slovenia (2016b). Strategic Guidelines for Further Implementation of ICT in the Slovenian Education Until 2020. http://www.mizs.gov.si/fileadmin/mizs.gov.si/pageuploads/URI/Slovenian_Strategic_Guidelines_ICT_in_education.pdf

Digital Education Policies in Europe and Beyond (2017), https://publications.jrc.ec.europa.eu/repository/bitstream/JRC109311/jrc109311_digedupol_2017-12_final.pdf

Innovating education and educating for innovation (2016), http://www.oecd.org/education/ceri/GEIS2016-Background-document.pdf

Learning Science in Immersive Virtual Reality (January 2018), https://www.researchgate.net/publication/322708154_Learning_Science_in_Immersive_Virtual_Reality

Virtual reality and its potential for Europe (May 2017), https://ec.europa.eu/futurium/en/system/files/ged/vr_ecosystem_eu_report_0.pdf

Virtual education in education (October 2019), https://www.mdpi.com/2078-2489/10/10/318/htm

Slovenian Educational Network – official website, https://skupnost.sio.si/

Bregar, L., Zagmajster, M. & Radovan, M. (2010). E-izobraževanje za digitalno družbo. Ljubljana: Andragoški center Slovenije. GS Search 23. March 2020, https://www.acs.si/digitalna-bralnica/e-izobrazevanje-za-digitalno-druzbo/

videolectures.net - official website, http://videolectures.net/

Habeeb Omer, A. (2018). Mobile Learning; Selecting the Right Authoring Tool For Mobile Learning. eLearning Industry. https://elearningindustry.com/right--authoring-tool-for-mobile-learning-selecting [GS Search: 4. 3. 2020]

Pandey, A. (b. d.). 12 Examples that Prove Mobile Learning and Microlearning is an Essential Combination to Meet Your Learning Mandate, https://elearningindustry.com/free-ebooks/mobile-learning-and-microlearning-combination-training-examples [GS Search: 4. 3. 2020]

Blum, A. (August 16, 2018). The Multiple Uses of Augmented Reality in Education. GS Search 2. March 2020, https://www.emergingedtech.com/2018/08/multiple-uses-of-augmented-reality-in-education/

Inovativna šola - official website, https://www.inovativna-sola.si/

Van Leeuwen, A. (November 2018). Teachers' perceptions of the usability of learning analytics reports in a flipped university course: when and how does information become actionable knowledge? GS Search 2. March 2020, https://www.researchgate.net/publication/329206532_Teachers'_perceptions_of_the_usability_of_learning_analytics_reports_in_a_flipped_university_course_when_and_how_does_information_become_actionable_knowledge

Učilnice Arnes – official website, https://ucilnice.arnes.si/?lang=sl

E-gradiva – official website, http://egradiva.gis.si/web/egradiva-ss

Alias A.K. (Sep 27, 2014). Flipped Classroom, Mobile Learning, WhatsApp, and Learning Nuggets; A simple model of a flipped classroom leveraging mobile devices, social media and the concept of microlearning. GS Search 3. March 2020, https://medium.com/anecdotes-of-academia/flipped-classroom-mobile-learning-whatsapp-and-learning-nuggets-e63f1c6a8e78

Fernandez M. (June 30, 2017). Augmented Virtual Reality: How to Improve Education Systems. Universidad Europea de Madrid. GS Search 15. March 2020, https://www.researchgate.net/publication/318615917_Augmented_Virtual_Reality_How_to_improve_education_systems

Página Oficial del Instituto Nacional de Tecnologías Educativas y Formación del Profesorado. https://intef.es/

Página Oficial The Flipped Classroom España, https://www.theflippedclassroom.es/

The Flipped Classroom; Aprendizaje basado en el alumno. Recursos Educativos. Inspiratics. https://www.inspiratics.org/es/recursos-educativos/the-flipped-classroom-aprendizaje-basado-en-el-alumno

Equipo pedagógico de Campus Educación. (2019). Cómo llevar a cabo las Flipped Classroom. Campus Educación. https://www.campuseducacion.com/blog/recursos/articulos-campuseducacion/como-llevar-a-cabo-las-flipped-classroom/

Los cuatro pilares del aprendizaje invertido. ¿Qué es el aprendizaje invertido o flipped learning? Flipped Learning. https://flippedlearning.org/wp-content/uploads/2016/07/PilaresFlip.pdf

40 herramientas para aplicar la metodología flipped classroom en el aula. Recursos TIC. Blog educativo. Aula planeta. https://www.aulaplaneta.com/2015/05/12/recursos-tic/40-herramientas-para-aplicar-la-metodologia-flipped-classroom-en-el-aula-infografia/

Adrián Alonso. ¿Qué es el flipped learning y cómo usa las nuevas tecnologías para la enseñanza? Educación. Mutua Madrileña, https://www.mutua.es/blog/educacion/flipped-learning-tecnologia-para-ensenanza_post/

Centro Aragonés de Tecnologías para la Educación – Página Oficial. https://web.catedu.es/webcatedu/

Isabel Sonsoles de Soto García. (2018). Flipped Classroom como herramienta para fomentar el trabajo colaborativo y la motivación en el aprendizaje de geología. Edutec. Revista electrónica de tecnología educative. file:///C:/Users/Usuario/Downloads/1239-Texto%20del%20art%C3%ADculo-3973-1-10-20190208.pdf

Fundación Orange. (2016) La transformación digital del sector educación. http://www.fundacionorange.es/wp-content/uploads/2016/11/eE_La_transformacion_digital_del_sector_educacion-1.pdf

Casanova López, O. y Serrano Pastor, R. (2018) Recursos tecnológicos y educativos destinados al enfoque pedagógico Flipped Learning. Revista de docencia universitaria. https://pdfs.semanticscholar.org/780e/7cb0b043c1c35d97b441a2af5d99b4a78a4f.pdf

¿Qué es el M-learning? (2016) Artículos pedagógicos. Innovación educativa. Tekmaneducation. https://www.tekmaneducation.com/blog/2016/10/04/que-es-el-m-learning/

Santiago Moll (2016) M-learning, qué es, para qué sirve y qué usos tiene en el aula. Justifica tu respuesta. https://justificaturespuesta.com/m-learning-que-es-para-que-sirve-usos-en-aula/

Diego Sánchez (2017) ¿Sabes qué es el aprendizaje mobile o mobile learning? Vértice. https://www.vertice.org/blog/sabes-aprendizaje-movil-mobile-learning/

Qué es mobile learning (m-learning) IT Business School. IT Madrid. https://www.itmadrid.com/que-es-mobile-learning-m-learning/

¿Cómo incorporar el mobile learning en el aula? Educación. Noticias. Universia. https://noticias.universia.com.ar/educacion/noticia/2018/05/10/1159769/como-incorporar-mobile-learning-aula.html

Frías, J. (2020) Mobile Learning. Una propuesta para usar el móvil dentro del aula. JJ Frías. http://jjfrias.com/mobile-learning-en-educacion

Acuña, M. (2017) M-Learning. Educación móvil en el aula. Evirtualplus. https://www.evirtualplus.com/m-learning-educacion-movil/

Mosquera Gende, I. (2018) M-Learning: ventajas e inconvenientes del uso educativo del móvil. Unir Revista. https://www.unir.net/educacion/revista/noticias/m-learning-ventajas-e-inconvenientes-del-uso-educativo-del-movil/549203604580/

Guía para la implantación del MOBILE LEARNING. Universidad Politécnica de Madrid. http://serviciosgate.upm.es/docs/asesoramiento/guia_implementacion_movil.pdf

Guía Mobile Learning. Fundación Telefónica. https://observatorio.profuturo.education/wp-content/uploads/2016/04/Guia_MobLearning.pdf

Camacho, M. y Lara, T. (2011) M-Learning en España, Portugal y América Latina. Monográfico SCOPEO. Universidad de Salamanca. http://scopeo.usal.es/wp-content/uploads/2013/04/scopeom003.pdf

Calvo, J. (2018) Realidad Virtual y Realidad Aumentada ¿Una moda o una herramienta educativa? European Valley. https://www.europeanvalley.es/noticias/realidad-virtual-y-realidad-aumentada-en-educacion-una-herramienta-educativa/

Observatorio de Innovación Educativa del Tecnológico de Monterrey. Realidad Aumentada y Realidad Virtual. Universidad Icesi. Eduteka. http://eduteka.icesi.edu.co/articulos/edutrends-realidad-virtual-y-aumentada

Realidad Virtual y Realidad Aumentada en el aula: todo un potencial para incorporar en tus clases. (2020) Unir Revista. https://www.unir.net/educacion/revista/noticias/realidad-virtual-aumentada-en-el-aula/549204965972/

Realidad Aumentada en Educación: El boom que viene. IAT. https://iat.es/tecnologias/realidad-aumentada/educacion/#:~:text=%C2%BFQu%C3%A9%20entendemos%20por%20realidad%20aumentada,trav%C3%A9s%20de%20un%20dispositivo%20electr%C3%B3nico.

Blazquez Sevilla, A. (2017) Realidad Aumentada en Educación. Gabinete te Telecomunicación. Universidad Politécnica de Madrid. http://oa.upm.es/45985/1/Realidad_Aumentada__Educacion.pdf

http://facultyinnovate.utexas.edu/how-to-flip

http://cft.vanderbilt.edu/guides-sub-pages/clickers/#what

http://www.rivistabricks.it/wp-content/uploads/2017/08/02_Gabbari.pdf

http://iris.uniroma1.it/retrieve/handle/11573/1182454/1065675/Andreoli_La-realt%c3%a0-virtuale_2018.pdf

http://www.cipat.it/public/file/Modulo%203_Realt%C3%A0%20virtuale.doc

associazioneitalianaformatori.it/download/articoliln/2015/LN11_12_15Bentivogli.pdf

http://www.vitecoelearning.eu/e-learning-e-realta-aumentata-applicazioni-e-vantaggi/

http://www.ai4business.it/intelligenza-artificiale/realta-aumentata/realta-virtuale-realta-aumentata-cosa-sono/

http://www.pmf-research.eu/la-realta-virtuale-nellapprendimento/

http://kknews.it/visori-vr-perche-sono-importanti-a-scuola/

http://www.lumi4innovation.it/formazione-professionale-4-0-con-realta-virtuale-e-realta-aumentata/

http://www.realmore.net/cose-la-realta-virtuale-come-funzina-ed-ambiti-di-applicazione/

http://www.realmore.net/cose-la-realta-aumentata-come-funziona-ed-ambiti-di-applicazione/

http://krpano.com/home/

http://www.flippedclass.com

http://www.jonbergmann.com

T. Rosenberg, Turning Education Upside Down, New York Times, 2013 (http://opinionator.blogs.nytimes.com/2013/10/09/turning-education-upside-down/)

http://www.techsmith.com/flipped-classroom.html

flippedhighschool.com/

http://ocw.mit.edu

http://www.khanacademy.org/

http://www.minstructor.pl/

http://www.mcourser.pl/

http://www.bobr.edu.pl/

http://www.erasmusplus.org.pl/

An impressive series of Virtual reality helmet drawings found in the US patents, http://nearfuturelaboratory.com/.

Archeoguide, http://archeoguide.intranet.gr/.

Augmented Reality - The Future of Education, praca studencka w zakresie projektowania graficznego i multimediów - autor Sorin Voicu, http://www.youtube.com/.

Augmented reality in military, http://teambluehci.blogspot.com/.

Augmented Reality Sightseeing, Fraunhofer IGD, http://www.youtube.com/.

BMW augmented reality, http://www.youtube.com/.

K. Bonsor, How augmented reality works, http://computer.howstuffworks.com/.

S. Heining, F. Euler, B. Ockert, Virtual mirror: Interaction paradigm for augmented reality, http://campar.in.tum.de/.

Holographics + Augmented Reality, http://www.youtube.com/.

Interactive Tourist Guide using Augmented Reality, http://www.youtube.com/.

Interaktywna broszura, http://www.youtube.com/.

T. Kanade, Z-Key: A New Method for Creating Virtual Reality, http://www.cs.cmu.edu/.

Layar, http://www.adv.pl/.

Outdoor Collaborative Augmented Reality, http://www.ims.tuwien.ac.at/.

Project A Future for the Past exhibition of Allard Pierson Museum, http://www.igd.fraunhofer.de/.

Projekt Muzeum Powstania Warszawskiego oraz Adv.pl, http://www.youtube.com/.

Projekt Golden Submarine: http://www.goldensubmarine.com/.

Rozszerzona rzeczywistość - telefonia komórkowa, http://www.youtube.com/.

Total Immersion, http://www.youtube.com/.

Tuscany+ iPhone Augmented Reality App, http://www.youtube.com/.

Virtual Sightseeing Augmented Reality Scenic Viewer - Cascais Lookout Point, http://www.youtube.com/.

Vidina Project, Zastosowanie AR w telefonii komórkowej, http://www.youtube.com/

http://www.oecd.org/education/ceri/GEIS2016-Background-document.pdf

https://www.portugal.gov.pt/download-ficheiros/ficheiro.aspx?v=6ac404ca-9f41-4d83-ae70-6ffff158803b

https://bibliotecadigital.ipb.pt/handle/10198/7431

https://www.incode2030.gov.pt/

https://www.erte.dge.mec.pt/

http://mobilelab.dge.mec.pt/Portal/Pages/Homepage.aspx

www.flippedlearning.org/definition

https://flippedlearning.org/wpcontent/uploads/2016/07/WhitePaper_FlippedLearnin.pdf

https://www.depaul.edu/Pages/default.aspx

https://resources.depaul.edu/teaching-commons/teaching guides/technology/Pages/mobile-learning.aspx

https://www.researchgate.net/publication/324825213_THE_FLIPPED_CLASSROOM_AN_APPROACH_TO_TEACHING_AND_LEARNING_MATHEMATICS_EDUCATION

http://www.eun.org/documents/411753/839549/Country+Report+Portugal+2017.pdf/78bd8a2c-999c-469e-ac36-ef9574f32e8f

https://repositorio.ul.pt/bitstream/10451/29335/1/ulfpie051428_tm.pdf

https://invisible.toys/virtual-reality-development/virtual-reality-in-education/

https://www.vr-school.eu/uploads/io2/EN/Module%203_Virtual%20Reality_EN.pdf

https://www.researchgate.net/publication/268002587_Reasons_to_Use_Virtual_Reality_in_Education_and_Training_Courses_and_a_Model_to_Determine_When_to_Use_Virtual_Reality

https://edudownloads.azureedge.net/msdownloads/MicrosoftEducation_Immersive_Experiences_Education_2019.pdf

https://spearheadelearning.com/virtual-augmented-reality-elearning/

https://www.researchgate.net/publication/227980620_Communication_Within_Virtual_Reality_Creating_a_Space_for_Research

Digital VET

DIGITAL TEACHING IN VET SYSTEM

www.digitalvet.eu