DIGITAL.VET – DIGITAL TEACHING IN VET SYSTEM

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

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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.

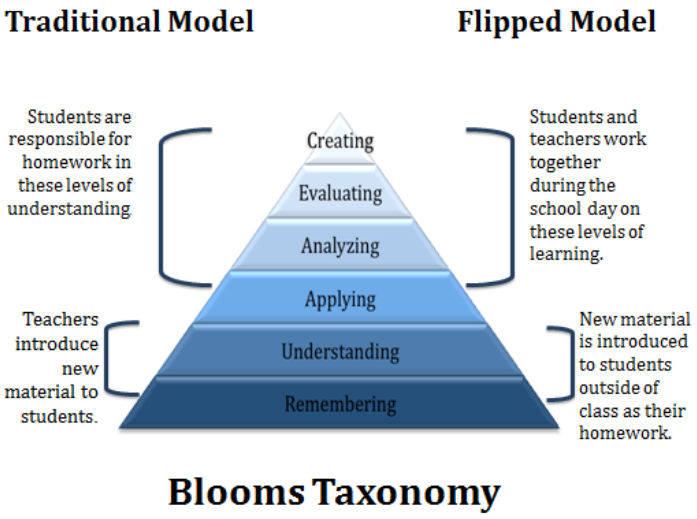


Fig. 1. Bloom's Taxonomy applied to traditional classroom activities and flipped classroom activities [http://nextgenerationextension.org/2013/10/01/blooms-and-the-flipped-classroom/]

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.

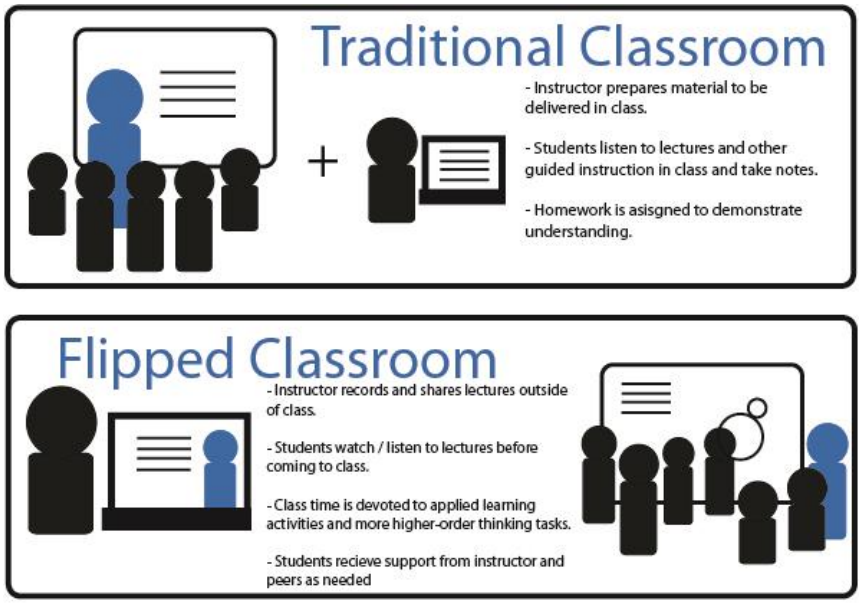


Fig. 2. Traditional classroom activities and flipped classroom activities [http://www.slu.edu/cttl/resources/teaching-tips-and-resources/flipped-classroom-resources]

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.

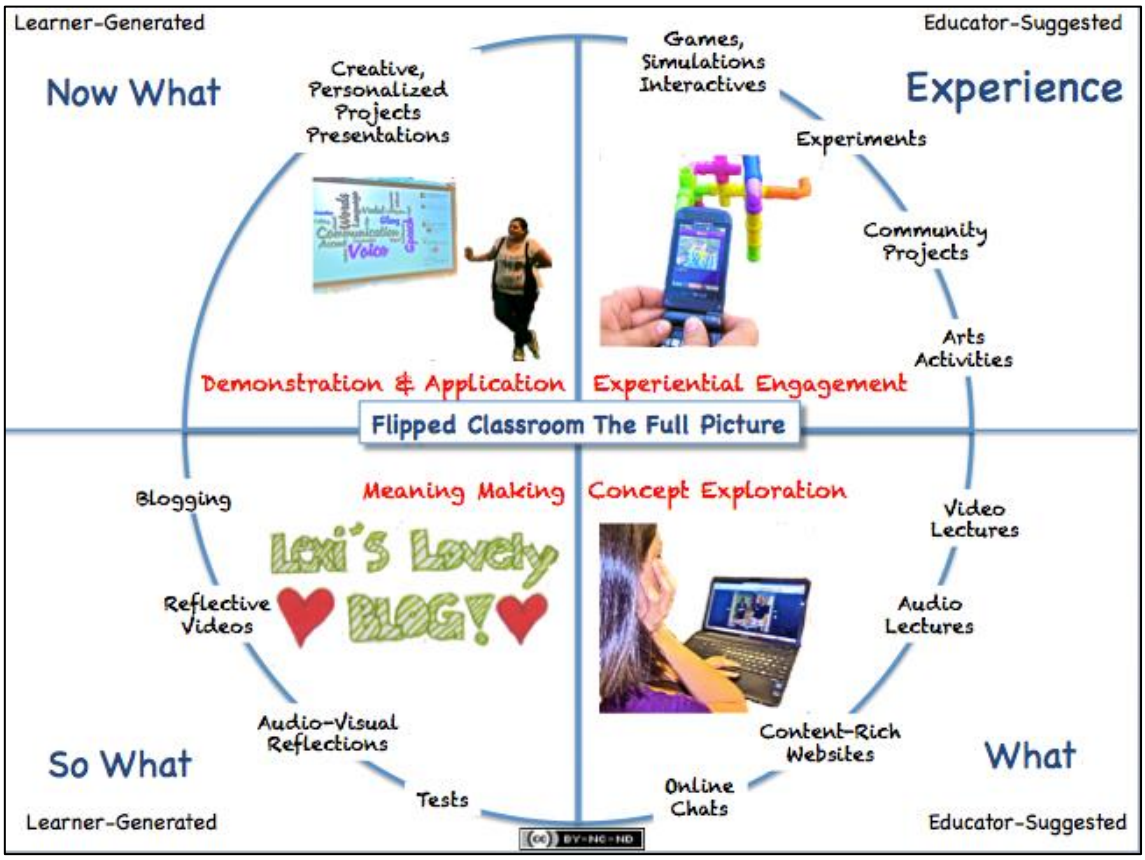


Fig. 3. Phases of flipped learning activities

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

Technology in the twenty-first century puts instantaneous access to information, and the Internet can be handily accessed through numerous technology tools such as laptop, computer, and Smartphone (Fu, 2013). Now more than ever, students spend much of their waking time on using some sort of technology tools; by using this technology, it is possible for them to interact with friends, instructors, and learning content everywhere, not only in the class but also outside the class through distance learning (Fisher, 2009). Also, many free learning materials have been provided on Web sites for learning activities. Richter and McPherson (2012) argued that in today's digital age, every student can access many free Internet learning resources such as online video lectures and they can watch these free contents everywhere and at their convenience. Even more, the use of the traditional learning approach which focuses on the instructor as the centre of knowledge is irrelevant in today's digital age (Wang & Heffernan, 2010). As a solution, traditional classroom activities such as lectures, labs, homework, and exams can be moved to the Web 2.0 technology and students can study everywhere outside the classroom (Staker & Horn, 2012). This positive impact of technology growth has influenced the development of instructional technology in education and replaced the use of the blackboard with online video lectures (Evans, 2011).

Halili, Razak, and Zainuddin (2014) mentioned that the use of Web 2.0 technology in education can build professional relationships through collaborating, coaching, and mentoring for social interactions in sharing ideas. In other words, by using various technological devices, the learners can study in different locations and times through collaborative distance learning. Therefore, living in a digital age demands the learners to work independently and collaboratively before coming to the classroom using various technology tools. New learning instructions that have emerged are now influencing education positively and producing students' independent learning. Indeed, technology in education is an ever-evolving process and demands the students and instructor always update the emerging technology in education. According to the Horizon Report which focuses on exploring and reporting emerging technology in education, the flipped classroom has been highlighted as an emerging technology for higher education which

is very important to use at college level (Johnson, Adams Becker, Estrada, & Freeman, 2014).

In recent years, the flipped classroom has become one of emerging technologies in education and it can be a standard of teaching-learning practice to foster students' active learning in higher education (Hamdan, McKnight, McKnight, & Arfstrom, 2013). The flipped classroom is an approach to teaching and learning activities where students watch a video lesson outside the class through distance learning and have hands-on activities in the class. Halili and Zainuddin (2015) note that the flipped classroom or reverse classroom is an element of blended learning, integrating both face-to-face learning in the class through group discussion and distance learning outside the class by watching asynchronous video lessons and online collaboration. Blended learning is simply defined as the activity of teaching and learning which combined face-to-face physical activities with online learning (Heilesen, 2010; Lean, Moizer, & Newbery, 2014; Poon, 2014). Blended learning was practiced by mixed face-to-face and distance teaching and learning or the integration of both distance and face-to-face modalities to deliver instruction.

Flipped classroom is also known as a student-centred approach to learning where the students are more active than the instructor in the classroom activity. In this case, the instructor acts as a facilitator to motivate, guide, and give feedback on students' performance (Sams & Bergmann, 2012). Hence, by applying the flipped classroom approach to teaching and learning activities, the instructor can move the traditional lecturer's talk to video and the students can listen to the lectures anywhere outside of class. The flipped classroom allows students to watch the video according to their preferred time and need, and they can study at their own pace; this type of activity also increases students' collaborative learning in distance education outside the class. Thus, by flipping the class, the students will not spend so much time listening to long lectures in the classroom, but will have more time to solve problems individually or collaboratively through distance learning with peers. Applying flipped classroom approach also contributes to better understanding of technology use in teaching and learning activities; students will use various technology media in learning activities independently, while the lecturer will use various technology media in their teaching practices (Zainuddin & Attaran, 2015).

6.1.1. Activities/phases of teaching model

The study of flipped classrooms was based on the theory of Bloom's revised taxonomy of cognitive domain. This taxonomy provides six levels of learning. The explanation is arranged from the lowest level to the highest level:

1. Remembering: in this stage, the students try to recognize and recall the information they receive; they also try to understand the basic concepts and principles of the content they have learned.

2. Understanding: the students try to demonstrate their understanding, interpret the information and summarize what they have learned.
3. Applying: the students practice what they have learned or apply knowledge to the actual situation.
4. Analyzing: the students use their critical thinking in solving the problem, debate with friends, compare the answer with peers, and produce a summary. The students obtain new knowledge and ideas after implementing critical thinking or a debate in group activities. In this level of learning, the students also produce creative thinking.
5. Evaluating: assessment or established peer-review knowledge, judge in relational terms; in this stage, students are evaluating the whole learning concepts and they could evaluate or make judgment on how far they successfully learned.
6. Creating: the students are able to design, construct and produce something new from what they have learned (Bloom, 1969).

In implementing flipped classroom, remembering and understanding as the lowest levels of cognitive domain are practiced outside the class hour (Krathwohl & Anderson, 2010). While in the classroom, the learners focused on higher forms of cognitive work, including applying, analyzing, evaluating, and creating. The figure 4 illustrates the level of students' learning in the flipped learning according to Bloom's revised taxonomy.

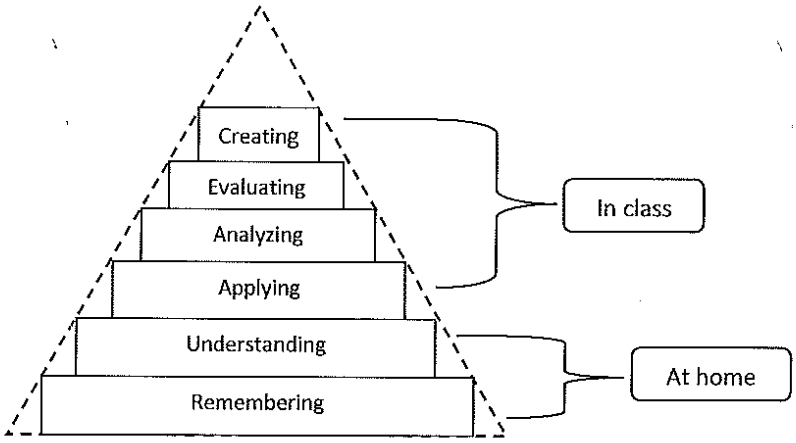


Fig. 4. Bloom's revised taxonomy in the flipped classroom

With the flipped model, the lower levels are presented before class through recorded lectures and video. Readings, simulations, and other materials also provide this foundational support for learning so that in-class time can be spent working on higher levels of learning from application to evaluation. In flipped classrooms, students go from the lowest level (remembering) to achieve the highest level (creating). Lankford (2013) mentioned that the flipped classroom focuses on how to support the learners in

achieving a higher level of the taxonomy domain. Additionally, Nederveld and Berge (2015) added that in flipped learning, classroom activity is spent on application and higher-level of learning rather than listening to lectures and other lower-level thinking tasks. Implementing flipped learning allows the students to spend more time supporting higher-level learning tasks such as a group discussion, while lower-level tasks such as knowledge and comprehension are completed independently outside the class.

In addition, several studies showed that the flipped classroom had positive impacts on teaching and learning practice. A number of positive impacts in flipped learning practice: students' achievement, students' motivation, students' engagement, and students' interaction, have been found.

Students' achievement. Achievement tests can provide an accurate snapshot of how well students are performing on various subjects. The structure of innovative learning environment and pedagogical strategy is the most pivotal factor that will increase student achievement in learning activities (Huang & Chiu, 2015). Therefore, the main goal of the emergence of the flipped classroom in education is to enhance student learning and achievement by focusing class time activities on student understanding and hands-on activities rather than on lecture. Some researchers have implemented the flipped classroom model to examine students' achievement in learning various subjects. The following reports showed that the flipped classroom model has effectively supported students' learning achievements with several motives.

Previous studies reported that students in flipped classrooms could obtain similar high examination scores when the class was flipped and that they could prepare for the subject before coming to class (Galway et al., 2014). Davies et al. (2013) conducted a study to explore how the use of technology in the flipped classroom might be utilized to effectively promote students' achievement. The findings showed that using technology was effective and scalable in a flipped classroom, and students' post-test scores in a flipped classroom improved compared to their pre-test scores. In term of pre-test and post-test comparison achievement, other studies also reported in which students statistically improved their learning and mastering of the subject in a post-test. In other words, the students have shown that they can understand the learning content and obtain a high score in the test or exam (Enfield, 2013; Kong, 2014; Talley & Scherer, 2013).

Furthermore, applying flipped classroom model is more effective compared to traditional classroom in term of students' achievement. Beapler et al. (2014) released the results of their research showing that students' outcomes in a flipped classroom were significantly better than those in a conventional classroom or control class, and students' perceptions of the learning environment were also improved. Hung (2015) in her study reported that the structured and semi-structured flip lessons were more effective instructional designs than the non-flip lessons (flip > semi-flip, flip > non-flip, $p < .05$) in teaching the English language. In the same manner, McGivney-Burelle and Xue

(2013) also noticed that flipping pedagogy in calculus was effective and worth the significant investment of faculty time and effort compared to traditional class.

Formative assessment was also one of the reasons that students improved their learning achievements. The instructor always gave feedback to facilitate students' improvement. Kim et al. (2014) noted that through formative assessment in the flipped classroom, the instructor could evaluate students' improvement in their learning activities while the students could understand what needed to be done to overcome their deficiencies in learning. Additionally, according to report by McGivney-Burelle and Xue (2013), students' ability to pause and re-watch the videos at any time may affect students' effective learning; they also enable students to take notes from the videos at their own pace.

Student's motivation. Besides students' achievement or effective learning, students' motivation also played a significant role in implementing the flipped classroom. Motivation is an inner power that pushes humans to take an action or move toward a goal (Harmon-Jones, Harmon-Jones, & Price, 2013). Students' motivation is defined as a spirit, initiative, and willingness of students to attend and learn material (Cole, Field, & Harris, 2004). In education, motivation is acknowledged as one of the most crucial elements which support students' performance and achievement.

According to self-determination theory, students' motivation is distinguished into two main types: intrinsic and extrinsic motivation (Abeysekeraa & Dawson, 2015). Intrinsic motivation refers to those actions that individuals engage in as they are inherently interesting, fun, exciting, and enjoyable, while extrinsic motivation refers to individuals engaging in actions because they lead to reward or to avoid punishment (Deci & Ryan, 2002; Ryan & Deci, 2000). The flipped classroom promots students' empowerment, development, and ability to learn independently or at their own pace (McLaughlin et al., 2013; Galway et al., 2014).

Even more, the flipped classroom's success relies upon students undertaking substantial out-of-class work – and being motivated to do so independently (Kim et al., 2014). Many studies showed that the impact of applying the flipped classroom was to increase students' motivation in relation to learning activities. For example, Davies et al. (2013) mentioned that students were able to learn based on simulated learning and that they were motivated to learn at their own pace; they also noted that the students wished to recommend the flipped classroom to their other friends.

The flipped classroom also increases self-perceived knowledge or self-efficacy in independent learning (Galway et al., 2014; Enfield, 2013). McLaughlin et al. (2014) mentioned that the strategy of the flipped learning approach will foster students' motivation in further learning. Their study indicated that the ILAM LMS (Integrated Learning Accelerator Modules) allowed students to learn at their own pace outside the class. In terms of in independent learning, McGivney-Burelle and Xue (2013) also noted that students are able to work at their own pace in class. Therefore, it can be implied

that learning environments created by the flipped classroom approach are likely to satisfy students' needs for competence, autonomy, and relatedness and, thus, entice greater levels of intrinsic motivation.

Students' engagement. The next positive impact is enhancing students' engagement. All researchers probably agree that the aim of flipped learning is to establish students' engagement with active learning. Students' engagement refers to students' active learning or students' desire to actively participate in routine class activity such as submitting homework, listening to the topic, working on what the instructor asks them to do, and actively attending the class (Yang & Cheng, 2014). Likewise, Zepke, Leach and Butler (2009) mentioned that students' engagement resulted from students' motivation. The term students' engagement is frequently used for students' active learning or students' desire to actively participate in routine class activity such as submitting homework, listening to the topic, working on what the instructor asks to do, and actively attending the class (Delialioglu, 2012).

Several studies showed that students had engaged in the flipped classroom. Kim et al. (2014) reported that students were able to prepare for in-class activities by watching and exploring on-line learning materials (e.g., online video lectures) before coming to class. Students felt confident when learning in the class because they had already prepared the lesson before coming to class. Talley and Scherer (2013) also reported that students could confidently produce a summary of the biological process in their own words by implementing the flipped classroom and they could be active in the class. Other researchers also mentioned students' confidence – by interacting with asynchronous video lectures outside the class, they could be more confident and prepared when participating in discussions in the class (Kim et al., 2014).

Students can enhance their engagement in classroom activity, participate in discussions, exchange ideas, and solve problems with their peers (McLaughlin et al., 2013). The use of the flipped classroom also promotes students' empowerment, development, engagement, and critical thinking. The study conducted by Chen et al. (2014) reported that students were satisfied with the class meeting, their attendance of the class was improved, and they had opportunities for active learning rather than listening to long lectures. He also mentioned that the number of students who came to class in the flipped classroom (in 2013) was 110, which was better than the previous year (in 2012) when the class was not flipped and the number of students was 88. Hung (2015) reported that the students engage the learning environment and engaged in the learning process. McLaughlin et al. (2014) also reported that students participated and engaged in discussions in class, and they were confident in their ability to apply the knowledge. Additionally, McGivney-Burelle and Xue (2013) also noted that students enjoyed having the instructor available in class to help them while they worked on problems.

From all findings, it showed that the flipped classroom has been successfully practiced to better engage students in learning various subjects. In contrast, the class without flipping or traditional class tends to produce disengaged learning environment because this conventional learning model has some problems. For example, teaching and learning activities only focus on text books and lectures, and students tend to be disengaged in active learning because they have a lack of time to express their abilities or performances in class. Traditional learning tends to produce a low level of student engagement, and students often pay less attention to the subjects they learn (Carini, Kuh, & Klein, 2006). Nguyen (2010) also noted that traditional class activities also focus on textbooks and lecture talks; students tend to be disengaged in their learning activity. Hence, students who are disengaged in learning will show some negative habits such as boredom, restlessness, and disruptive behavior (Freeman et al., 2007).

Students' interaction. Students' interaction is the other positive impact in a flipped classroom environment either in the classroom or in distance learning. Students' interaction refers to students' communication with all the elements in the learning environment including the instructor, students, and content (Woo & Reeves, 2007). It proves that students' social interaction in technology learning environment is more effective than that in traditional classroom without using technology; students in traditional classroom only interact physically in the classroom but not outside class hours (Wang, 2013). It can be assumed that students' social interactions will increase when technology media is integrated in teaching-learning activities. Technology use will indeed help students interact easily with all communities both inside and outside the class.

According to Moore (1989), three fundamental interactions should be established for successful teaching-learning with technology-based learning: student-content interaction, student-teacher interaction and student-student interaction. Hillman, Willis, and Gunawardena (1994) suggested student-interface interaction or interaction with technology tools as the fourth interaction to complete Moore's concept. All these interactions are very significant elements to apply in the flipped classroom approach in which technology is used as media to relearn and interact outside the classroom. Roach (2014) reported in his research that the students responded positively about flipping the classroom because the instruction helped them to collaborate with each other to solve problems. The flipped classroom enabled students to build a learning community and exchange ideas to solve problems (Kim et al., 2014). Another reported that it could build the dialogue inside the class or virtually through distance learning outside the class hours (McLaughlin et al., 2013).

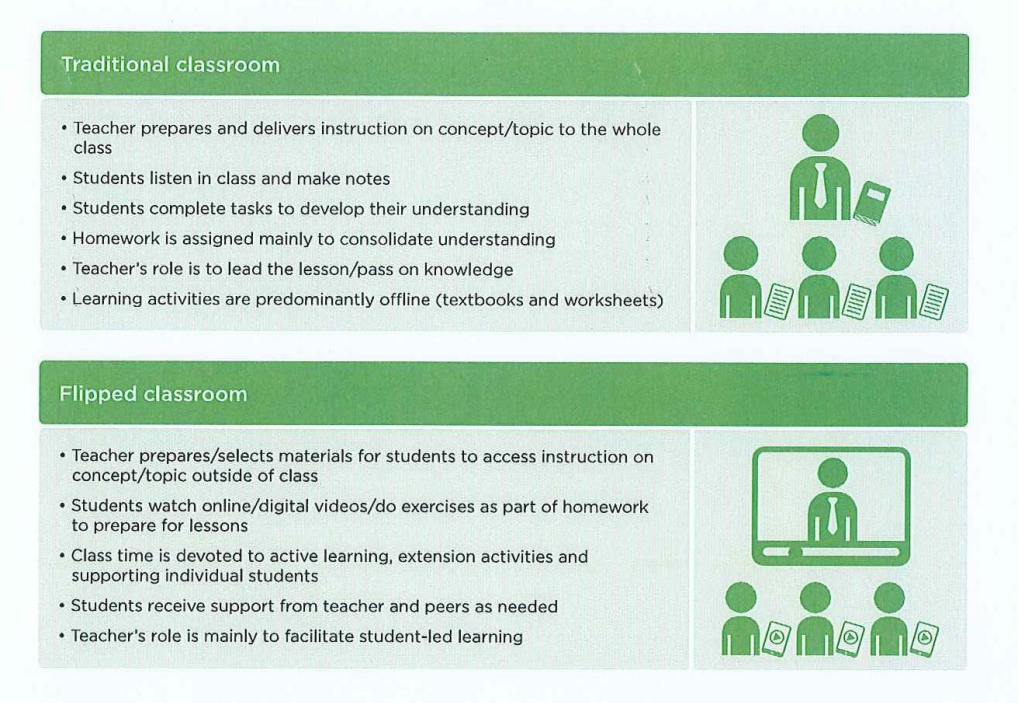
Love et al. (2014) compared the effectiveness of two teaching methods (a traditional lecture and a flipped style) in a sophomore-level linear algebra course at a mid-sized metropolitan university. The findings showed that the students had a positive perception of the flipped classroom according to their experience of studying for one

semester. It was mentioned that students had more opportunities to interact with one another and this helped them learn from other students. Missildine et al. (2013) reported that the blending of new technology and the traditional classroom had established students' interactive learning, particularly outside the class through LMS. Another study mentioned that students can enrich the dialogue with their friends both inside and outside the class because the activity of teaching-learning in a flipped classroom is not just limited to behind the classroom wall (McLaughlin et al., 2013). Also, Hung (2015) reported that 75 students (64%) in flipped learning class increased their interactions with the instructor and classmates.

Flipped learning involves the use of technology to maximise the time spent on active learning in school. Part of the learning process (usually direct instruction of new concepts through video) is accessed by students outside of the school day. This frees up classroom time for other activities, such as practising and applying knowledge and skills, collaborative learning and individualised support from the teacher, particularly to support students who are struggling. For the purposes of this study, we used the following definition of flipped learning:

"*In flipped learning, delivery of content is undertaken via video instruction accessed online. Class time is focused on supporting students in working out the problems themselves. The activities undertaken in the classroom should, where available, be informed by online data (such as that collected through practice questions) which will show teachers what their students are doing and the pace they are moving at*."

Some of the main differences between a traditional classroom and a flipped classroom are illustrated in the following diagram.



Flipping the classroom (also known as “inverting” a classroom) is a “pedagogy-first” approach to teaching in which course materials are introduced outside of class, and in-class time is re-purposed for inquiry, application, and assessment in order to better meet the needs of individual learners.

There are numerous ways to flip a class. Below are resources on how to get started and strategies and examples to determine what kind of flip is best for a courses.

The main goal in flipping a class is to cultivate more deeply engaged learning experiences for students when the instructor is present to coach and guide them. Emphasis is on higher-order thinking skills and application to complex problems.

Common activities include:

- *Collaborative learning*: collaborative learning can occur peer-to-peer or in larger groups. Peer learning, or peer instruction, is a type of collaborative learning that involves students working in pairs or small groups to discuss concepts or find solutions to problems. Similar to the idea that two or three heads are better than one, educational researchers have found that through peer instruction, students teach each other by addressing misunderstandings and clarifying misconceptions.
- *Case-based learning*: case-based learning (CBL) is an established approach used across disciplines where students apply their knowledge to real-world scenarios, promoting higher levels of cognition (see Bloom’s Taxonomy). In CBL classrooms, students typically work in groups on case studies, stories involving one or more characters and/or scenarios. The cases present a disciplinary problem or problems for which students devise solutions under the guidance of the instructor. CBL has a strong history of successful implementation in medical, law, and business schools, and is increasingly used within undergraduate education, particularly within pre-professional majors and the sciences (Herreid, 1994). This method involves guided inquiry and is grounded in constructivism whereby students form new meanings by interacting with their knowledge and the environment (Lee, 2012).
- *Peer instruction*: one goal of Peer Instruction (PI) is to revolutionize students’ learning experiences in class. In order to do this, instructors must move the easier task of direct instruction or content delivery out of the classroom and bring move extensive practice with knowledge transfer in. That’s where PI changes the learning game.
- *Problem set*: a problem set is a teaching tool used by many universities. It is essentially a list of several mildly difficult problems or exercises based on material already taught, which the student is expected to solve with a full written solution. There is no further research involved, and the goal is to learn and become familiar with the material and solving typical problems

There are numerous ways to flip a class. Below are resources on how to get started and strategies and examples to determine what kind of flip is best for a courses.

Step 1: Identify where the flipped classroom model makes the most sense for your course. The following questions may help you identify a good place to start, whether you have designed your course around learning outcomes or by units:

- In which class sessions do you currently have an in-class activity that you rarely have time to complete during class and requires the students to apply their knowledge and skills?
- What concepts or topics do students struggle the most to understand, based on exam scores and/or assignment grades?
- On what topics would students benefit from the opportunity to apply concepts under your expert guidance in the classroom?

Step 2: Spend class time engaging students in application activities with feedback. The crux of the issue is figuring out for your class how class time could be repurposed in ways that provide students with an appropriate level of challenge while leveraging your expertise as a coach or guide. There are many possibilities for infusing a class with collaborative learning experiences. Utlimately, it comes down to finding an approach that works best for your students and your course content.

There are a wide variety of evidence-based instructional approaches that create engaging class environments, here are a few approaches being used to create collaboration and problem solving in small and large classes.

- *Peer Instruction*: students prepare for class and give instructors feedback about what they found confusing or difficult. During class, students experience cycles of mini-lectures interspersed with peer discussion of conceptual questions that work to elicit, confront, and resolve misconceptions students may hold. For more information, visit the Peer Instruction Blog.
- *Team-based Learning (TBL)*: students prepare before class and experience readiness-assurance quiz over the content at the start of class (first as individuals and then as a team). Teams get immediate feedback on their performance while instructors address gaps in understanding via mini-lectures. Next, teams engage in structured application activities that conclude with teams simultaneously making a specific choice.
- *Case-based Learning*: students work together in small groups with guidance from the instructor to analyze the problem and evaluate a given course of action or decide on one of their own.
- *Process-oriented Guided Inquiry Learning*: POGIL activities are designed around the learning cycle where students explore data or information guided by questions, generate conclusions based on the data, and apply these

concepts in new situations. The activities are structured to develop process skills, critical thinking, problem solving and collaboration.

Assessment techniques can help inform and enhance learning when questions that measure student understanding are embedded into in-class learning activities:

- Provides students with feedback about what they know and do not know.
- Provides instructors with real-time data that informs instruction.
- Encourages students to engage during class by holding them accountable for their preparation.

6.1.2. Educational resources

Flipping the classroom (also known as “inverting” a classroom) is a “pedagogy-first” approach to teaching in which course materials are introduced outside of class, and in-class time is re-purposed for inquiry, application, and assessment in order to better meet the needs of individual learners. Course materials might include readings, pre-recorded video lectures (using technology such as Panopto), or research assignments. In-class activities might involve helping students work through course material individually and in groups, among other active learning strategies for students to gain practice applying knowledge gained prior to class.

When planning Learning Activities (LA), teachers must take into account the physical and virtual environments where learning activities take place, what technologies required are available, and what their own roles are and those performed by students and family members/parents or others, e.g. experts, students' friends, classmates, etc., allowing students the possibility of developing teamwork outside school. Even so, the teacher needs to allow students some time to perform individual and collaborative tasks in teams, in the classroom or in the laboratory, depending on students' needs and styles. The teacher also needs to plan and design moments of reflection and building assessment tools for students and for the teacher him/herself.

6.1.3. Technologies used

In applying the flipped classroom approach, there are various technology tools such as Wikis and Blogs can be employed to interact virtually outside the class and used to work collaboratively to solve problems or exchange ideas. These tools allow the users to share text, pictures, and videos with other users during distance learning (Pempek, Yermolayeva, & Calvert, 2009). Various technology tools or online platforms have been used by students to access online video or contents before coming to class. The students also used these platform tools to study through online collaboration outside the class. Staker and Horn (2012) mentioned that the activity of teaching and learning is not only limited to behind the classroom wall, but can also take place outside the class. Therefore, by using various technology media or online platforms, students can study

virtually, watch learning subjects for free all the time and interact with students and instructors outside of the class.

Here, we share some examples of different online platforms used in the flipped classroom practice. Love et al. (2014) reported that the screencasts were developed specifically in a flipped linear algebra course and the instructor created the presentations using the LaTeX beamer package. Roach (2014) used a Blog as online platform to share the video lectures; students had to access and watch one video per week that was available on a Blog. Hung (2015) used a WebQuest to establish students' active learning in and English language class. Missildine et al. (2013) reported that 16 master's-prepared faculty members taught two courses via interactive television on three campuses. While Kim et al. (2014) reported that students in a flipped classroom watched video lectures on YouTube and collaborated on Google Docs and Google Hangout.

Panopto is the UW-IT supported lecture capture solution. Panopto allows for easy recording and reviewing of videos from courses, lectures, and presentations. As a cloud-enabled service, Panopto is designed to simplify the lecture capture process. Recordings in Panopto are viewable on most Web browsers and mobile devices. No service fee for eligible users. Panopto helps to:

- Record and view lectures and presentations
- Share recordings
- Schedule recordings
- Upload recordings
- Add captions to recordings.

A Classroom Response System (CRS) allows instructors to ask questions to the class, then immediately gather and display student responses. There are many options on the market that offer a range of functionality depending upon what you are wanting to achieve.

A classroom response system (sometimes called a personal response system, student response system, or audience response system) is a set of hardware and software that facilitates teaching activities such as the following.

- A teacher poses a multiple-choice question to his or her students via an overhead or computer projector.
- Each student submits an answer to the question using a handheld transmitter (a "clicker") that beams a radio-frequency signal to a receiver attached to the teacher's computer.
- Software on the teacher's computer collects the students' answers and produces a bar chart showing how many students chose each of the answer choices.

- The teacher makes “on the fly” instructional choices in response to the bar chart by, for example, leading students in a discussion of the merits of each answer choice or asking students to discuss the question in small groups.

Teaching with a CRS can take a number of directions. Teachers will want to match activities to course content, time constraints, learning objectives, and their own teaching styles. Some possibilities for CRS activities include the following, listed more or less in order of increasing levels of student engagement.

- *Attendance*: clickers can be used to take attendance directly (e.g. asking students to respond to the question “Are you here today?”) or indirectly by determining which students used their clickers during class.
- *Summative Assessment*: clickers can be used for graded activities, such as multiple-choice quizzes or even tests. Some brands of clickers allow for a “student-paced” mode in which students answer questions on a printed test at their own pace.
- *Formative Assessment*: clickers can be used to pose questions to students and collect their answers for the purpose of providing real-time information about student learning to both the instructor and the students. Students can use this feedback to monitor their own learning, and instructors can use it to change how they manage class “on the fly” in response to student learning needs. Some brands of clickers allow students to register their confidence level (high, medium, or low) along with their answer, providing more detailed feedback to the instructor.Some instructors assign participation grades to these kinds of formative assessments to encourage students to participate. Other instructors assign points for correct answers to encourage students to take these questions more seriously. Other instructors do a mix of both, assigning partial credit for wrong answers.
- *Homework Collection*: some brands of clickers allow students to record their answers to multiple-choice or free response homework questions outside of class and submit their answers via the clickers at the start of class.
- *Discussion Warm-Up*: posing a question, giving students time to think about it and record their answers via clickers, and then displaying the results can be an effective way to warm a class up for a class-wide discussion. Compared with the approach of taking the first hand that is raised after a question is asked, this approach gives all students time to think about and commit to an answer, setting the stage for greater discussion participation.
- *Contingent Teaching*: since it can occasionally be challenging to determine what students understand and what they do not understand, clickers can be used to gauge that in real-time during class and modify one’s lesson plan accordingly. If

the clicker data show that students understand a given topic, then the instructor can move on to the next one. If not, then more time can be spent on the topic, perhaps involving more lecture, class discussion, or another clicker question. This approach has been called "agile teaching" by Beatty et al. (2006), who write, "This contrasts with the common practice of teaching according to a 'ballistic' lesson plan: designing a plan for an entire class meeting, 'launching' the plan, hoping that it hits reasonably close to its target, and waiting for the next exam to know for certain." Certainly there are other ways to determine if students are understanding course material as one progresses through a course, but clickers can provide a convenient way of doing s (Draper & Brown 2004).

- *Peer Instruction*: the teacher poses a question to his or her students. The students ponder the question silently and transmit their individual answers using the clickers. The teacher checks the histogram of student responses. If significant numbers of students choose the wrong answer, the teacher instructs the students to discuss the question with their neighbor. After a few minutes of discussion, the students submit their answers again. This technique often (but not always!) results in more students choosing the correct answer as a result of the peer instruction phase of the activity. This is a fairly simple way to use clickers to engage a large number of students in discussions about course material. This approach can also set the stage for a class-wide discussion that more fully engages all students (Mazur 1997).
- *Repeated Questions*: in the peer instruction approach described above, students respond to a given question twice–once after thinking about their answer individually and again after discussing it with their neighbor. Some instructors ask the same question several times, with different activities in between rounds of voting designed to help students better answer the question. For instance, an instructor might have the students answer the question individually, then discuss it with their neighbor and respond, then participate in a class-wide discussion and respond, and then listen to a mini-lecture on the topic and respond. For particularly challenging questions, this can be an effective technique for helping students discover and explore course material.
- *Question-Driven Instruction*: this approach combines contingent teaching and peer instruction. Lesson plans consist entirely of clicker questions. Which questions are asked depends entirely on how students answer the questions. An instructor might come into class with a stack of clicker questions, with multiple questions on each topic. As students perform well on clicker questions, the instructor moves on to questions on new topics. As students perform poorly, the instructor asks further questions on the same topic. The instructor

does not have a lesson plan in the traditional sense when using this approach. Instead, the course of the class is determined reactively to demonstrated student learning needs (Beatty et al. 2006).

- *"Choose Your Own Adventure" Classes*: in this technique, an instructor poses a problem along with several possible approaches to solving it – perhaps approaches suggested by students during class. The instructor has the students vote on which approach to pursue first, then explores that approach with the students. Afterwards, the students vote on which approach to pursue next. See Hinde and Hunt (2006) for an example of this approach.

Online tools might use are the following:

Padlet (*http://padlet.com/*) is a web application which enables ideas to be expressed on a topic and to be easily organized. It could be useful to present a proposal for a work project, to design a project or learning scenario. Padlet allows embedding online documents (e.g. images, video, pdf, etc.), and documents that can be uploaded from a computer.

Popplet (*http://popplet.com/*) is an internet application that can be used to record a brainstorming session, allowing people to express their thoughts about a certain topic in an easy and visual way, organizing ideas and concepts and their relations by linking them, creating a mapped structure of concepts, ideas or flow options. The application allows collaborative use by different users, from any kind of device. It is a kind of multimedia friendly tool, free-form or a real-time wiki.

Lino-it (*http://en.linoit.com/*) is a web application similar to a corkboard where you can post sticky notes, create a structure of information that you collect. One can express him/herself by the means of text or graphics, video or files existing online or uploaded from computers.

FolioFor.me (*http://foliofor.me/*) is an online system to create e-portfolios based on Mahara. It allows uploading documents from a computer or an already published online.

WebQuest (*http://createwebquest.com/*) is a system that allows creating and sharing online learning-oriented activities following the model developed by Bernie Dodge at the San Diego State University. Usually a WebQuest has 6 sections: Introduction, Task, Process, Evaluation, Conclusion and References or Credits. This activity aims to help students organize their learning tasks in a logical way, and share them later with peers. Working in small groups, students can use existing tools in Virtual Learning Environments like Edmodo or Moodle or can take advantage of tools like Padlet, Popplet and Lino-it, as shown above, or make use of other tools to build concept maps as MindMup.

MindMup (*http://www.mindmup.com*) is an Internet application that helps to construct concept maps, which easily integrates with Google Drive. Concept maps can

be collaboratively edited, shared and exported in different formats (e.g. PNG, HTML, FreeMind).

WeVideo (*https://www.wevideo.com/*) is an online video editing enabling the use of our own resources (sources of video, images and audio). The interface is simple and intuitive. Once the video is rendered the publication can be made directly in some video distributors like YouTube or Vimeo or shared online through Google Drive or DropBox for instance.

Loopster (*http://www.loopster.com*) is an online application for nonlinear video editing, using a traditional interface. Resources like audio, video and images can be transferred from the user's computer. The storage capacity is 2.5 GB and the lifetime of the resources is 1 month only. After editing, the system renders the video and sends an email message with a link to the video. Users can decide if the publication is public, personal, or restricted.

EasyPolls (*http://www.easypolls.net/*) is a very effective and comprehensive system to conduct online polls. Students can use this feature to decide on various options or to choose the subjects of their discussions.

ClassDojo (*http://www.classdojo.com/*) is a fully online class manager that can track students' progress. Teachers can use it to record student learning and share it with them and with their families, while maintaining a level of assessment and information updated and accessible. Students can access a set of reviews and information about their performance which contributes to self-regulation of their attitudes and behaviors. Family members can also track the progress of students, accessing information and records that the teacher registers on the platform.

6.1.4. Learning topics and places

The flipped classroom had been implemented in various areas of study. Morgan (2014) mentioned that many instructors from different fields of study in the United States of America (USA) tried to conduct experiments study in using the flipped classroom approach. Sams and Bergmann (2012) also showed that flipped classroom instruction is not only applied in chemistry and math classes, but also in all areas of study.

Various studies in flipped classroom in 2013, 2014 and 2015 showed different fields of studies, including science and social courses, such as information systems (Davies et al., 2013), chemistry (Baepler et al., 2014), algebra (Love et al., 2014), economics (Roach, 2014), engineering, sociology and humanities (Kim et al., 2014), integrated humanities (Kong, 2014), physiology (Talley & Scherer, 2013), statistics (Touchton, 2015), public health (Simpson & Richards, 2015), calculus (McGivney-Burelle & Xue, 2013), science, technology, engineering, or mathematics (STEM; McLaughlin et al., 2014), business (Warner et al., 2014), and English language (Hung, 2015).

In twenty-first century, there is a trend toward usage of digital resources and communication tools in education (Kong, 2015). These tools provide teachers to help

students exemplify and understand concepts easily through animations or various computer models, and it gives chance teachers and students to make contact with peers and experts anywhere on the world (Zucker, 2008). It is one of the important goal in higher education in the 21st century to reform teacher education programs through the establishing the active learning environments that support students learning (Keengwe, Onchwari, & Onchwari, 2009). At that point, it is important to designing learning environment through to students need.

In 21st century, the idea of flipped classrooms is enables students to access resources without any a specific place in limited time. In the early of 1990s, Gall, Gall, Jacobsen, and Bullock (1990) designed special instruction content for physics courses. Students' activities in classroom settings were asking questions, laboratory, and sections. In the context of education software were clicking words, symbols, interactive simulation, interactive problems. The idea was that provide students to choose content their individual needs. In 2007, two science teachers asked that question "What if we prerecorded all of our lectures, students viewed the video as 'homework', and then we used the entire class period to help students with the concepts they don't understand?" (Eldredge, 1990). They used "flipped classroom" concept for that model.

Brame (2013) identified four key elements of the flipped classroom based on students' developing and understanding of factual knowledge in the context of a conceptual framework:

- Provide an opportunity for students to gain first exposure prior to class.
- Provide an incentive for students to prepare for class.
- Provide a mechanism to assess student understanding.
- Provide in-class activities that focus on higher level cognitive activities.

In addition and more specifically, flipped learning is a flexible learning environment. FLN (2014) was defined the four pillars of F-L-I-P. The first pillar is flexible environment: it allows creating flexible spaces in which students choose when-where they want to learn. The second pillar is learning culture: students are actively involved in knowledge construction based on a learner-centered approach. Pillar three is intentional content:

educators determine what they need to teach and what kind of materials student should use for maximizing classroom time in order to active learning strategy. The final pillar is professional educator: instructor must actively scaffold learning with continuously observe students and give feedback, and assessing their work to support self-directed learning.

6.1.5. Communication channels

Using technology in educational settings is becoming a standard for 21st century's learners. The Internet changed the instruction and learning model. Learner can use internet for learning activity any time and teacher also use it for distance instruction.

Today, numbers of learner are taking distance and blended courses from educational institutions (Gemin, Pape, Vashaw, & Watson, 2015; Staker, 2011). In order to effectively use the technology, we need to develop new instructional strategies, methods and techniques that are learner-centered (Gillani, 2003).

In order to prepare the web based content, course objectives were identified, learning outcomes for each lecture were determined, and content coverage was defined. Various video prepared for every lecture. Also, some of lecture was included reading text activity. All the knowledge or skill points in each lecture were included in different videos (possible to web viewing and download). Each video lasted 2-20 minutes. The researcher utilized video and reading text resources from many websites such as YouTube.

6.1.6. Usability condition

However predictable and trivial they may be, the usability conditions that allow students and teachers to use platforms on which to load and take lessons in advance of the physical lesson in the classroom, can essentially be classified in a few points: accessibility to a network internet, possession of an HMI technological device such as tablet, pc or smartphone, and an e-mail box as well as basic technological skills to meet the need for online teaching. (The IWB - Interactive Witheboard at the service of inverted learning Flipped Learning: a "new" teaching with digital technologies).

6.1.7. 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

Over the past two decades, technology devices have become mobile – portable and networked – to the point that they have become pervasive in everyday life. The use of

mobile devices has become common among a wide range of age groups due to affordability and availability (Newhouse, Williams, & Pearson, 2006). Significant investments have been made to provide infrastructure, content, and resources related to the integration of mobile devices into learning environments (Johnson, Smith, Willis, Levine, & Haywood, 2011), and researchers have long had an interest in this evolving landscape (Kukulska-Hulme, Sharples, Milrad, Arnedillo-Sánchez, & Vavoula, 2009). However several limitations exist, such as lack of theoretical and pedagogical underpinnings, sustainable integration into formal educational contexts, and, particularly, lack of teacher support and training (Cochrane, 2012; Peng, Su, Chou, & Tsai, 2009).

Teacher support and teacher training have been the least explored topics in mobile learning research (Ekanayake & Wishart, 2014). Mobile learning is especially under-theorized in teacher education (Kearney & Maher, 2013), despite the need to inform teachers of the value of mobile technologies and how to integrate them effectively into their classes (Schuck, Aubusson, Kearney, & Burden, 2013). In their review of mobile learning projects conducted in Europe, Kukulska-Hulme et al. (2009) revealed that at the "European and individual state level, there appears to be little teacher development or training activity addressing mobile learning" (p. 14). Challenges related to teachers' adoption of mobile technologies have emerged from the fact that they are not effectively prepared to investigate the advantages or make informed decisions (Kukulska-Hulme et al., 2009; Schuck et al., 2013). Because of both the pressure to provide teachers with effective technology integration skills and the rapid growth of mobile technologies as learning devices, teacher education programs need to implement theoretically and pedagogically sound mobile learning initiatives (Newhouse et al., 2006).

Mobile technology has been developed rapidly in almost every sector nowadays. One of the sectors that show development is education. Especially due to the mobile phones and handheld computers, it is very easy to reach the information.

According to Lehner et al. (2003, p. 24), a shift from 'electronic' to 'mobile' service has begun with the paradigm of 'anytime, anywhere computing' and so, mobile learning is the next step in the evolution of e-learning.

They define (p. 24) mobile education as "any service or facility that supplies a learner with general electronic information and educational content that aids in the acquisition of knowledge, regardless of location and time".

Rosman (2008, p. 119) describes mobile learning as "an array of ways that people learn or stay connected with their learning environments while going mobile". He states that e-learning takes learning away from the classroom or campus and mobile learning takes learning away from a fixed point, so e-learning is an alternative or complementary to classroom learning and mobile learning is a complementary activity to both e-learning and traditional learning (p. 121). Shih et al. (2011a, 373-374) state that mobile learning

is the advanced model following-e-learning which uses devices like personal digital assistants (PDAs), mobile phones, portable computers.

The main characteristics of mobile devices are portability, instant connectivity and context sensitivity which respectively mean that they can be taken to different locations, they can be used to access a variety of information anytime and anywhere, and they can be used to find and gather real or simulated data (Cheon et al. (2012, p. 1055).

Life-long learning and just in time learning are the other advantages (Gulsecen et al., 2010, p. 796). There are also some disadvantages of mobile learning such as limited memory, small screen, disconnection at times and limited battery life.

Learning in a mobile environment would become more interesting, because mobile tools like smart phones have also computing facilities which allow the users to communicate with other people and to create documents, read data files, and access the Internet, besides communication facilities (Hussin et al., 2012, p. 277). Recent innovative technology like tablet PCs or iPAD also provide a more convenient way of computing and of communicating with people while users can receive emails, instant messages in text forms or multimedia formats, lecture notes, and audio and video files in 3G formats.

There may be also complexities about mobile learning, such as its cost, familiarization of both students and instructors, students' readiness, instructors' readiness and perception about the efficiency of it, implementation of mobile learning and technical limitations.

6.2.1. Activities/phases of teaching model

It is possible to identify some guidelines for the creation of an online teaching model to be adopted and used in different fields of knowledge and different situations. Since it is possible to identify two potential actors (teacher and students) of the online teaching model, it is appropriate to divide the phases according to the operating subject and the addressee of the contents.

As far as the teaching actor is concerned, he has the task of a clear, fast and understandable teaching so that learning takes place spontaneously and precisely; for this reason the teacher has the duty to prepare the lessons on the topic to be exposed to the class taking into account that the transmission vector is no longer a traditional teaching but an electronic teaching, and therefore needs useful precautions to pursue the purpose. It is possible to equip each online lesson with external supports to the lessons that can be transmitted through handouts to download, links for further information, online texts to consult, audio lessons to listen, all assisted by the watchful and expert eye of the teacher, who cannot to refrain from imparting his lesson.

Once the didactic material has been transmitted, through different channels according to the type of use or the "weight" of the download, the teacher will explain step by step what is reported in the documents, giving the possibility to the students to

understand the guidelines for the release of the attachments (SIMULWARE mLearning Revolution). Once the study time designed for the analysis of the teaching material has passed, the students will be able to prepare for a collective discussion with their classmates / colleagues so as to stimulate in them a critical ability to observe and study the facts. From this moment on, the lesson could be managed by the students who, by creating a constructive and critical discussion about the topic in question, could take the reins themselves by creating online assembly groups aimed at a continuous improvement of their learning and discernment skills.

All of course chaired by the teacher who must compulsorily act as guarantor about the teaching quality. The last part follows, not in importance but only from a temporal point of view, which is that of verification, aimed at testing the understanding and learning of students during the previous phases.

6.2.2. Educational resources

Online teaching, unlike traditional teaching, enjoys preferential tools aimed at continuous improvement of the teaching provided. If traditional teaching is based on tools already widely known and used in the field of training, such as textbooks, handouts, in-depth information sheets and less traditional supports such as the IWB which in some way could bring the traditional teaching experience closer to the telematic one, these however remain limited and limiting.

In telematic teaching, however, it is possible to use tools that approach traditional teaching, however these are supported by a wide range of tools, technologically called, such as online texts, audiovisual products, multimedia products, video lessons, video interviews and different online channels that deal with different topics such as specific blogs or networks etc.

Not to be underestimated in online teaching is the "time" resource, which is closely linked to the type of teaching provided as thanks to the telematic supports the student can take advantage of and leverage his / her learning times for a better knowledge of the subject matter. The time variable is the resource with the greatest weight within telematics teaching and a key element for better student performance (SIMULWARE mLearning Revolution).

6.2.3. Technologies used

Figure 5 shows the distribution of mobile devices used in the studies from 2011 to 2015. As indicated, the majority of studies (107) studied non-specific / generic mobile devices or learning across mobile devices. This may indicate that as technology changes so quickly, it may be best not to invest in a specific device as mobile learning can take place across a multitude of devices. This result may also be indicative of the growing realisation of Bring-Your-Own-Device (BYOD) (Cochrane, Antonczak, Keegan, & Narayan, 2014; Traxler, 2016). If one looks at the specific device trends, it is clear that mobile

phones (including smartphones) are the most frequently used devices in studies (73). It must be noted that 38 of the 73 studies using mobile phones specified the use of smartphones in particular. Tablets are also very frequently used in studies (33). For those studies that reported the specific brand of tablet, the Apple iPad was the overwhelmingly most used tablet brand.

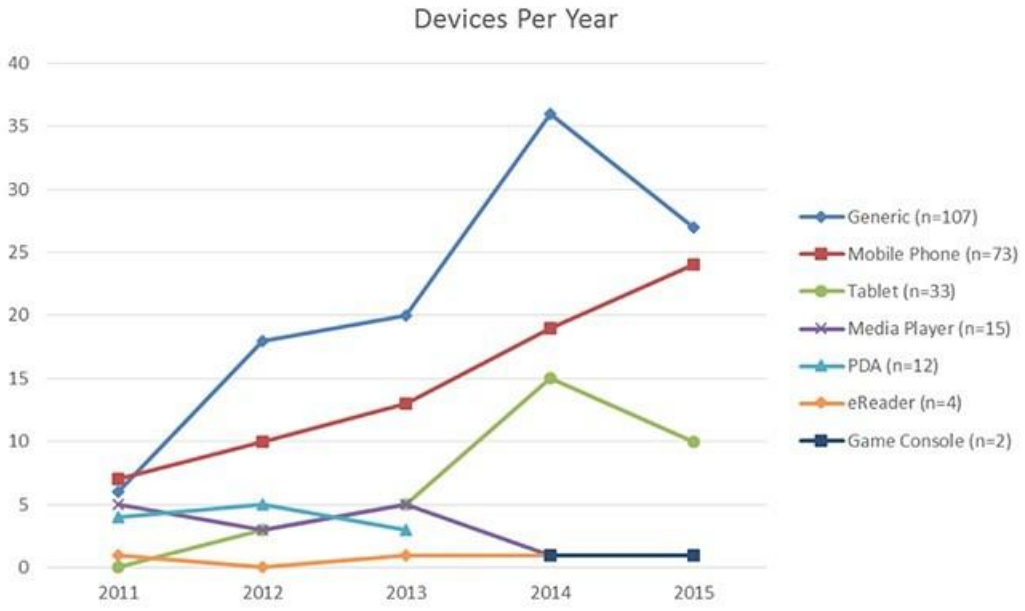


Fig. 5. Distribution of mobile devices by year

6.2.4. Learning topics and places

As far as the topics that can be treated through online teaching are concerned, these refer precisely to ministerial programs if it is a first and second grade school, to university programs if it is a university, for which there is no specific topic treated or negotiable through online teaching, as each topic can be adapted for this purpose, naturally excluding the practical topics that provide practical lessons.

A basic element to take advantage of online teaching is an internet connection, 3G or Wi-Fi. From this statement it is clear that any place can be suitable for online teaching (parks, studies, libraries, public squares or private homes), ascertained that these have an internet connection and that the technologies appointed for this purpose are in possession (Innovation in mobile learning).

6.2.5. Communication channels

Having overcome the physical barrier of the textbook, today teaching uses specific and technological channels for learning.

From simple platforms connected to the organization that provides teaching, to specific platforms designed to transmit educational documents that provide feedback such as Classroom or Argo, the student and teacher who approach mobile learning can

choose from a wide range of channels on which to provide or take advantage of teaching.

Also not to be underestimated are "commercial" channels such as Youtube, Whatsapp, Skype or Telegram, increasingly used for the dissemination of information (SIMULWARE mLearning Revolution) (M. Pieri The Accessibility of Mobile Learning).

6.2.6. Usability condition

As obvious and trivial as they may be, the usability conditions that allow students and teachers to take advantage of distance education are essentially classifiable in a few points: accessibility to an internet network, possession of an HMI technological device such as tablet, pc or smartphone, and an e-mail box as well as basic technological skills to meet the need for online training. Naturally, if the basic technical skills are lacking, for example due to the poor predisposition of the teaching staff to the use of new online platforms, the system in question for the supply of distance learning would lose its initial intent and its performing utility (M Pieri The Accessibility of Mobile Learning).

6.2.7. 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

Times and trends, especially in the IT field, are constantly evolving; the relationship between man and machine becomes more and more an important topic and this is the reason why there is the need to make it simpler and more intuitive. In a panorama in which the "virtual" is part of everyday life, two recent developments in digital technology stand as an innovative approach capable of remodeling the concepts of communication and reality. The products dedicated to these technologies and their possible applications are growing exponentially. Obviously we are talking about Virtual Reality and Augmented Reality.

Very often Virtual Reality and Augmented Reality are used as synonyms and associated with a viewer with which to see "things that are not really there", but it is not so, because even if they seem close to each other they constitute two somewhat different worlds:

- **Virtual Reality**: it is a three-dimensional representation generated by the computer, with different degrees of affinity with the real environment, from a schematic sketch of objects up to photorealism, in which it is possible to interactively act with the environment and objects. It stems from the desire to "replicate" reality, as precisely as possible from the visual, auditory, tactile and even olfactory point of view, to perform actions in the virtual space overcoming physical, economic and security limits.
- **Augmented Reality**: the term Augmented Reality means the superimposition of virtual elements generated by the computer to the perception of the real world, taken through a camera or through special glasses. In general, Augmented Reality (AR) is the representation of an altered reality in which artificial / virtual sensory information is superimposed on the normal reality perceived through our senses.

The fundamental difference between Augmented and Virtual Reality lies in the simulation concept used. Virtual Reality induces us, through a more or less immersive system, to think of living a certain reality by deceiving our senses; this reality is completely computer generated. The Augmented Reality, differently, adds information levels of various nature to what our senses perceive. In short, it is a perceptual-sensory enhancement, based mainly on the generation of virtual content by a computer and their overlap with reality. It is important to point out that these integrations are not

limited to visual data but can include, if technology allows, olfactory, auditory and even tactile data.

Virtual Reality has been applied for some time in many fields of human activity. The application of VR is already being widely tested also in the world of education: simulators, virtual laboratories, 3D virtual learning environments, to make only known examples. The combination of Augmented Reality technology with educational content, on the other hand, represents an area that is still under-explored. This possible "union" certainly opens up new and fascinating scenarios as well as stimulating the birth of a new type of digital application.

If VR is already widespread and already finds a lot of application in everyday life, AR applied to the educational world is a sector with an exponential growth perspective. The simplest use of AR, just to give some examples, can be easily experimented through mobile applications. Just point the device's camera towards something that the AR-application recognizes, and a 3D animation or video will be generated superimposed and integrated perfectly with everything on the camera screen. The product effect is amazing and very engaging.

These possible scenarios for an "increased teaching / learning" (through VR and / or AR) prelude to the creation of environments to improve the effectiveness and attractiveness of the didactic action and place teachers and (above all) students in virtual scenarios real life, with the aim of maximizing learning by making it more engaging.

6.3.1. Activities/phases of teaching model

"Augmented learning is an on-demand learning technique where the learning context, which is not necessarily the classroom or laboratory, is created according the needs and demands of the student" (Xiangyu Wang).

As you know, virtual reality and augmented reality create even more engaging learning experiences and allow you to amplify the effectiveness of learning based on interactive videos.

The human being remembers better what he sees rather than what he listens to, this is the reason why these technologies applied to e-learning can be an excellent tool for updating and training, allowing practical and experimental activities to transform the experience of learning in a playful and effective experience.

In fact, "learning by doing" is one of the best ways to decree the success of an immersive learning process. The changes brought by digital technologies, now available to everyone, have changed the way in which users interact. Augmented reality and virtual reality satisfy the principles of active learning and also have repercussions on the world of education: they can optimize the learning processes of students, for the purpose of better interaction between groups of students, above all to create positive interdependence and a sense of individual responsibility, to strengthen working groups and promote an interactive and effective type of learning.

In the outdoor learning path, augmented reality improves the overall student experience in different ways. Here are some further advantages of augmented reality applied to education:

- It allows you to “learn by doing”, therefore to develop knowledge in an active and autonomous way.
- It facilitates the research process of students, who having information on AR devices available, do not need any type of external intervention. In this way increases the threshold of attention and concentration on the task.
- It reduces the possibility of error, since theoretical information and its practical application occur simultaneously, facilitating memorization.
- It provide a thorough understanding, with new notions to be stored within your luggage. Augmented reality in education provides the opportunity to explore the mechanisms of the world and experience them firsthand.
- It effectively develops human memory skills, in fact when children learn using educational systems integrated with AR they can recall information more easily.
- It facilitates cooperation and stimulates collaboration between students.
- Learning with augmented reality means learning in stimulating and captivating ways, therefore it is fun and interesting.
- According to a MIUR survey, in 2016/2017 the number of students with specific learning disabilities in Italy is around 2.9% of the total number of pupils. Augmented reality is an excellent tool to meet the needs of children and teenagers with special educational needs.

Experimenting with AR means knowing that experience will change into a lasting change, precisely because the type of learning followed by reflection allows you to store the knowledge acquired. The change will take place on several levels: experience and intuition, reasoning and reflection.

The effectiveness of augmented reality lies precisely in the fact that it approaches real contexts and emulates them thus:

- Offering the student the stimuli and the task to be performed.
- Keeping the student's attention active on the task to be performed.
- Simplifying the student's homework.
- Restricting the possibilities of actions for solving the task.

It would therefore be a tool that acts at various levels on the learning process, placing itself now as a tool capable of enriching the experience, now as an environment, now as a tool capable of helping and providing the directives necessary to achieve the objectives set.

To date, AR seems to be an effective tool not only for strategies applied to marketing and entertainment, but also the entire learning process. This is due to the ease and practicality of this technology, the quality of the experience that users have and the decrease in construction costs. In fact, the AR apps are many and allow educators to experiment with new ways of learning, which must not replace classic practices, but represent a middle ground capable of reconciling innovation and tradition.

Augmented reality has all the potential to become a standard tool within the education system. With it we move from the classic teaching-listening to a participatory study method in which both students and teachers engage in the learning process, becoming interested and participating actors. The so-called augmented learning aims precisely at the independence of the children and the stimulation of their creative and communicative skills.

In fact, AR is seen as a coherent and effective response to bridge the gap between standard systems and new needs in the field of education, precisely because it focuses on stimulating critical thinking and problem solving, to analyze situations from different points of view.

Virtual reality, unlike augmented reality, simulates actual reality, allowing you to navigate in realistic settings and interact with the objects in them. It can be totally immersive and the environment, fake but realistic, is used by the user thanks to some peripherals. In this case, the user's monitor will act as a window on the three-dimensional world with which it is possible to interact through specific inputs. The effect is different from the one offered by immersive virtual reality, which is more engaging and completely distracts the user from reality. Virtual reality exerts a particular influence on some human characteristics and favors interactive, participatory and inclusive way of teaching. The virtual world is the the best way for studying human social behavior and supporting new forms of communication. The instantaneous and realistic relationship lived with the virtual world respects the rules of reality. Being immersive, virtual reality directly involves the senses of the subject, isolating it from the stimuli of the real environment, leveraging on the cognitive resources of the subject.

The benefits of using virtual reality applications in e-learning are various:

- The user experience is always active and involvement is immediate.
- Immersive experiences facilitate concentration and raise the level of attention.
- Physical exploration of simulated spaces and times facilitates learning, knowledge and memorization.
- Experimental practice helps to understand complex issues, concepts and theories.
- Learning takes place in controlled, safe and protected spaces.
- Virtual scenarios can be very realistic and can be experienced and experienced remotely.

- The virtual reality experience is innovative and is generally perceived as pleasant (gamification).
- It makes things possible that in reality would not be possible, allowing learning processes during doing (learning by-doing) and experiencing firsthand what it means to be something or someone.

6.3.2. Educational resources

Printed paper, the most widespread communication support technology (from the book to the poster) is in itself still today mainly a "single-media and one-way" communication channel, but if integrated with AR, in connection with a video camera, and with an algorithm capable of recognizing the content of the page and in combination with a platform for retrieving the associated digital data, it is able to accompany the message, which is static and closed in itself, with different perceptive methods and with significant, dynamic additional content and multimedia that improves understanding. Several publishers, opening the way in the digital age to a new type of content consumption and enriching the consistency of printing with the instantaneousness of digital, are trying to introduce a new vitality in one of the most ancient means of communication thus allowing printing itself to become more interactive, engaging and useful. The union and combination of an AR system with the press are able to provide additional value to communication where the "whole" becomes more influential and significant than the sum of the individual parts.

To learn through VR, on the other hand, it is essential to have VR visors. Students "immerse themselves" in a 360 ° active learning environment, experimenting with images and sounds that dissolve the barrier between virtual and real. Using the tools, the students watch, speak and move freely in a virtual 3D environment, interacting with tools, machinery and other real simulated students and instructors. Teachers can thus "guide" students to anywhere in the world through collections of 360 ° scenes and 3D objects, indicating sites and elements of interest along the way.

6.3.3. Technologies used

When we talk about Virtual Reality, the first object in which we think about and that allows us to use this technology is undoubtedly the viewer, a helmet-shaped device or simple glasses that allows you to live a sensory experience in a "parallel" but tangible world. There are many viewers developed by various companies: Google Cardboard is a cardboard viewer accessible to everyone, compatible with both iOS and Android, which through a special app and connected to a smartphone allows you to see photos, videos and even visit monuments directly from home , as well as the Samsung Gear VR headset or the Facebook Oculus. In the gaming sector we find the Play Station vR, the display for PlayStation 4, or the Wired Gloves, gloves used instead of a mouse, keyboard, joystick and other manual input systems, to move, give commands and much other. Cybertuta,

on the other hand, is the suit that wraps the body and that can simulate the touch, make a three-dimensional scan of the user's body and transfer it to virtual environments. In this case, the user's monitor will act as a window on the three-dimensional world with which one interacts through specific inputs.

The effect is different from that offered by immersive virtual reality, which is more engaging and completely distracts the user from reality. Another example of Virtual Reality is given by 360 ° cameras, which promise to become the new standard for shooting and sharing choral scenes such as parties, concerts, family dinners, but pay attention not to overlap the two things: 360 video ° is not the same as saying Virtual Reality. If we refer to Virtual Reality as a highly interactive computer-generated environment, this definition does not apply to “real” shots obtained through a 360 ° video camera, although the 360 ° spherical movies usable thanks to VR glasses offer an immersive experience to all effects. The difference lies in the ways of interacting: while Virtual Reality sucks the viewer into a digital world, a panoramic clip is limited to providing a spherical version of the surrounding reality at the time of filming; in this case the spectator plays a passive role, cannot influence the action nor much less freely explore the context. In addition, the viewer can look around but only by taking the perspective of whoever shot the scene, practically moving his head up and down, left and right.

A noteworthy tool is definitely Krpano Viewer, a high-performance, small and very flexible viewer for all types of panoramic images and interactive virtual tours. It is available as a Flash and HTML5 application and is designed for being used within the browser on the desktop (Windows, Mac, Linux) and on mobile phones / tablets (iPhone, iPad, Android, etc.). The program also includes Krpano tools, which help to automatically prepare panoramic images for viewing and make them ready for use; taking a tour is possible simply by dragging and dropping.

To embed krpano viewer in an HTML page, you need to include the main script file "krpano.js" (the file name can be different) and call the *embedpano()* function. The embedpano function detects browser support and decides which krpano viewer to use (krpano HTML5 or krpano Flash viewer). Using the krpano Flash viewer, the embed script also applies various Flashplayer and Browser fixes and workarounds (for example, to enable the use of the mouse wheel within Flash on systems where it is not supported).

The krpano script file must be included once (but before using *embedpano()*) anywhere on the html page: *<script src = "krpano.js"> </ script>*

Create a * * element in which krpano must be incorporated anywhere in the html page, give that div a unique 'id' name and define its size using CSS styles:

* </ div>*

After defining the * * element, create a <script> element with the code of the embedding script. For the embedding itself there is the global function *embedpano()*:

embedpano ({... embedding parameters ...});

Complete example:

<script src = "krpano.js"> </ script>

* </ div>*

<Script>

embedpano ({swf: "krpano.swf", xml: "pano.xml", target: "pano"});

</ Script>

The *embedpano()* function needs a Javascript object as an argument. This object is used to pass all parameters (in random order) using parametername: pairs of values. Almost all parameters (except the target parameter) are optional: when they are not defined, their default values will be used.

Augmented Reality, on the other hand, requires the help of functional software equipped with specific interpretation-return and tracking devices. Among the devices created by large companies there are: Google, with Google Glass; Microsoft with Microsoft HoloLens and Sony with Sony SmartEyeglass. These devices, by identifying fixed points in a space, are able to trace objects and / or shapes by connecting them to the desired virtual objects (images, objects, virtual characters, 3D writings, video flow, etc.) and allowing to perform all the movements that take place in real time. AR allows you to increase, enhance and amplify what is already there, to connect information layers of various nature to what our senses are able to perceive, creating what can be defined as: "a simple perceptual enhancement ". In "simple" Augmented Reality, made practically accessible to anyone, at least two significant modalities can be classified:

Georeferenced AR: is carried out using a mobile platform (e.g. tablet, smartphone, etc.)

AR with visual metaphor: is realized through markers and the desktop of a computer.

Georeferenced Augmented Reality uses portable devices (phones, smartphones, tablets, laptops, etc.) which are now almost all equipped with GPS for positioning a magnetometer, and are also able to allow viewing of a video stream in real time, they also have an Internet connection to receive the information from the online. Using the smartphone's video camera, the surrounding reality is framed in real time and on this video footage the content levels detected by the data of the points of interest that were geolocated (geolocation and geotagging) to 3D elements are immediately superimposed.

Augmented reality with visual metaphor, created through the computer desktop, requires the use of markers (also called ARtag), which allow the camera to receive a specific visual signal to recall the correct information (applications called "markerbased"), or it might not need it (so-called "markerless" applications). Markerless applications have a wider applicability, as they work everywhere without the need for specific recognition or additional reference points. Markers are stylized drawings with the shape of a square or rectangle generally in black and white and contain an image

with a code (similar to a barcode). These markers are shown on the webcam of the PC or on the camera of the smartphone and through a software implementation are identified some codes which are interpreted and allow to superimpose on the image in real time the additional multimedia possible contents (images, videos, audio, 3D objects and all that has been prepared).

The **QR Code** (Quick Response Code) is an example of a facilitator marker used to store information, it consists of a two-dimensional bar code and a structure with white and black points arranged inside a square with a white background that allows encryption of several hundred characters. In Japan, where they were born, QR codes have now become an essential tool and are present on almost every advertising medium. The information contained in the code can be decoded and displayed with the help of a smartphone or tablet. 'QR' is the abbreviation for 'Quick Response' and refers to the particularly rapid scanning process. QR Codes can be printed on posters, books, newspapers and magazines, company websites, billboards for promotional campaigns, business cards and can thus be enriched with digital content. The variety of different application possibilities is practically unlimited. The image may contain messages, photos, videos, links to websites, PDF data documents and information that can be quickly accessed. To decode (read) a QR code, a device with a camera and simple software installed can understand the sequence of the graphic elements that make it up. The QR code manages to incorporate, in the size of a square, a large multiplicity of data that, for reasons of space or time, cannot always be communicated: it is like having an image on which to press the button to view the contents of a web page.

6.3.4. Learning topics and places

VR and AR offer a lot of possibilities: there are many examples of how they can promote learning and provide innovative experiences for students. Gochman et al. (2019) developed a VR tool, based on Unity 2018 with SteamVR for HTC Vive and Vive Pro headphones. Specifically, they used the Virtual Reality Toolkit (VRTK), an open source script library to develop a virtual reality. Their experience has allowed students to experience the difference between the eyes of a Tarsier, nocturnal primate, and the eyes of a human being. The experience was formally evaluated in secondary school, using a questionnaire as a tool for data collection. This successful experience clearly demonstrates how virtual reality can be used to simulate an otherwise impossible scenario.

A similar approach was followed by Akman and Çakir (2019), who developed a virtual reality-based game for learning mathematical fractions, a very difficult topic for students. Using cardboard glasses, a smartphone and headphones, the students had the opportunity to learn by playing. The experience was assessed through guided interviews, as a data collection tool, from which particular appreciation emerged for the application in terms of challenge, action, awareness, clear objectives, unequivocal feedback,

concentration on the task, sense of control, loss of self-awareness, transformation of time and autotelic experience.

Markowitz et al. (2018) used a virtual reality environment, developed in Worldviz's Vizard software, to allow students to understand the increasing acidification of the oceans as a consequence of climate change. This learning experience was applied in high school and the learning process was assessed through six open questions. As a result, the application has made it possible to increase knowledge about marine science, in particular the consequences of climate change. The authors found that after an immersive experience in virtual reality, people developed their knowledge and interest in knowing the causes and effects of ocean acidification, stimulating in some cases a change of pro-environment attitude.

Murphy et al. (2017) developed a virtual reality model of the Armagh Astronomical Observatory, through which it was possible to evaluate the position of the stars in the 18th century. The experimentation began with the evaluation of historic buildings and the development of a 3D model in Historic Building Information Modeling (HBIM), an extension of 3D CAD Building Information Modeling for the physical management of knowledge and the conservation of architectural heritage.

AR and VR obviously do not apply only in the field of education and training. In the Automotive sector, virtualization and 3D simulation can offer added value, since Virtual Reality is able to express great potential, both in engineering contexts and in product communication. As an example: creative drawing sessions in VR; concept study; evaluation of the CAD model in real scale; engineering design; driving simulations; crash test simulations; product configuration within dealers. The world of engineers and designers is transformed into a giant creative space, in which to give rise to one's imagination and creativity without any kind of limitation.

There are also those who, in the medical field, use Virtual Reality to train new "Healthcare" professionals: doctors are already experimenting these technologies with tangible results. The surgeon or nurse quickly acquires the skills and specifications of each step of the operating technique, following the results of their actions recreated in real time through the 3D simulator. In this way, the training of health workers is facilitated, once they are in the situation, they can experiment technique over and over again and train their ability to adapt to stressful situations. Virtual Reality is revolutionizing the real estate sector. The configuration of scale models of buildings and architectural constructions, and 360 ° Virtual Tours, allow you to present real estate in an extremely realistic way, offering great opportunities to customers and professionals. Real-time digital restyling of the interior and immersive navigation along the exact perimeter of a property in the countryside are no longer utopian.

Compared to technologies that are now widespread, Augmented Reality is an emerging technology that facilitates and increases the level of interaction between the user and what he is looking for. With the evolution and advent of new wearable devices,

digital information is no longer decontextualized on a flat screen but is virtually projected through holograms at the point where the action takes place or where the business develops.

Augmented reality can be used by companies to improve production processes, to assist the operator in the repair and maintenance of a machine, to design, to enhance sales and marketing, to increase safety at work, to "increase" the user's shopping experience, can be used in the medical field and much more.

6.3.5. Communication channels

In the new world panorama, in which social networks have conquered an ever greater share of the telecommunications market, they have started to make use of VR and AR to make themselves more attractive to the public by increasing their popularity and increasing their technological contribution. To date, there are several social platforms that allow the use of AR / VR technology for different purposes, from recreational to commercial, from educational to cognitive.

Youtube for some time now allows the display of virtual reality content making it a highly attractive platform for those who, through audiovisual media, want to communicate something to the general world audience; Tik Tok with its innovative formula of videos recorded in a few seconds, uses virtual reality and augmented reality to obtain amazing effects and in excellent definition, transmitting any type of communication (from the most banal to the most serious) with the possibility of become viral and have excellent visibility based on the quality of the video. As for Instagram, this platform used augmented reality for the first time to help users preview how certain products appear on their face, a novelty which then became a playful routine for all those who use social media in everyday life. The technology behind this condition is the same that feeds the effects of Instagram's camera and Facebook's augmented reality. The latter, in fact, with posts and 3D photos allows the use of content in a completely new and innovative way, projecting the user into a reality as real and "close" as possible. It is therefore clear that social networks seek an involvement and active participation of users by finding a satisfactory answer to these demanding ones in augmented and virtual reality. AR and VR consequently offer enormous user engagement opportunities and for these reasons they are increasingly popular as a marketing tool among the brands.

6.3.6. Usability condition

The usability conditions of VR and AR are based on the quality of the technology offered and the purpose to be achieved. At the basis of the usability conditions, in both cases, there is an Internet connection that shows as a fundamental condition for the VR and AR processes to take place. If the use of AR and VR is mainly limited to viewing a product or object, for example three-dimensional, a usability condition can be represented by a good smartphone on which it is possible to add apps that implement this activity. If

instead the user of AR and VR implies the reproduction of a realistic scenario with olfactory, tactile and auditory as well as visual interactions, the usability conditions change making them more complex to be implemented as a controlled place where it is necessary to use the aforementioned technology to be able to safely stop.

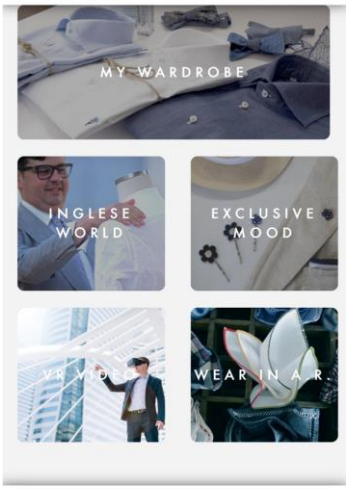
6.3.7. National practical examples

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.

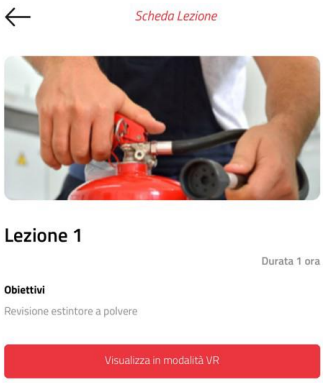
G. Inglese App:



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:



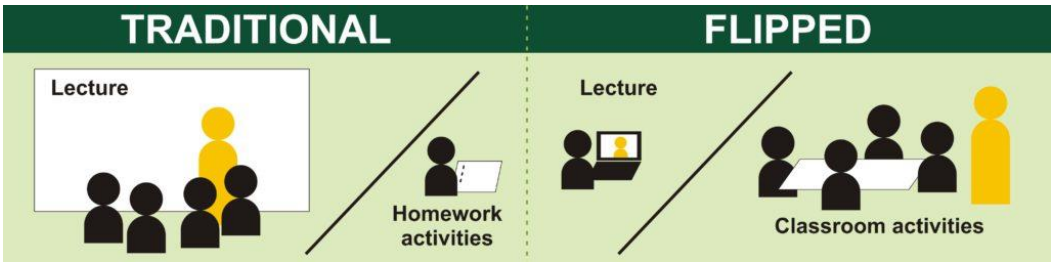
Another example of the application of VR is provided by Capurso trade & services, a leading company in the dairy products sector, based in Gioia del Colle (BA). the company has developed an anti-avoidance system with the help of virtual reality capable of understanding what the tastes of customers are;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

In the traditional teaching model, based on Bloom's taxonomy, the lesson begins with a topic given by the teacher, most often with a theoretical lecture (knowledge). Next the examples are presented and discussed (understanding). Finally, homework is given. The teacher in this model contains information, and students are passive recipients. Pupils at home, without the help of a teacher, must use advanced solutions based on theoretical cognitive assumptions in the lesson (application, analysis and synthesis). What if they have doubts, problems or something they don't understand? In the worst situation, they will get a low or negative grade for homework, and in the best situation they will turn to the teacher in the next lesson and receive the necessary help. Frequent problems with understanding medical material resulting in reduced self-esteem, demotivation, and sometimes escapes with unloved, i.e. incomprehensible activities.

Chemistry teachers Jonathan Bergmann and Aaron Sams from high school in Woodland Park, USA are considered the first practitioners who decided to use this method in education. In 2007, they recorded their lectures to enable students who leave classes to catch up. However, they quickly realized that the recordings were also popular among those present at the classes. Thanks to their commitment, the time devoted to introducing the lesson topic and explaining the basics of a given topic has been significantly reduced. The new method makes students more willing to cooperate, are more active and more often speak in the classroom forum. Teachers, in turn, finally have time for exercises to consolidate and check knowledge, they can also take lessons to help students with learning difficulties, while talented students are able to solve problems on their own.



Flipped classroom is a pedagogical model in which a typical lesson and homework change places. Short introductory videos on the new topic are watched by students before the lesson as a form of homework. In turn, the time spent in classes is devoted to exercises, projects or discussions. Movies are often seen as a key element of the reverse lesson. They are created and published by online teachers or selected from online resources. The ease with which you can access and watch video files means that the reverse lesson is increasingly used in various countries.

7.1.1. Activities/phases of teaching model

Before starting to work with the flipped lesson method, it is necessary to familiarize students with this method of teaching and learning, explain its principles and essence. Of course, they are presented in a completely different way to the youngest pupils and differently to high school students, with whom it is worth discussing the pros and cons of such action, anticipated difficulties and conditions for success.

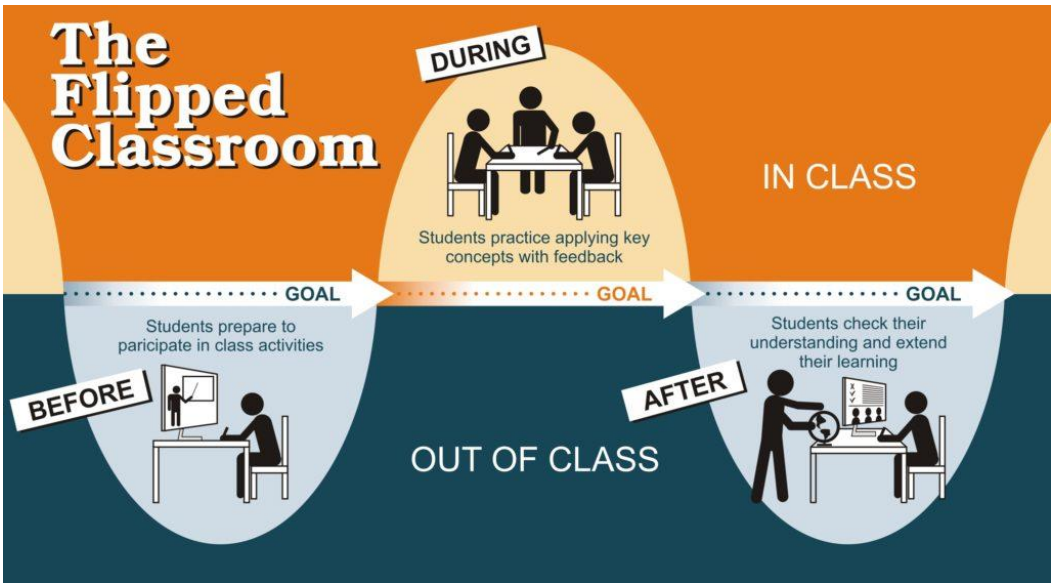
The activities and phases of the flipped teaching model can be realised according to the following:

1. **Planning the cycle, preparing materials**. Before starting the task, the teacher should think about the topic and the objectives, as in the preparation of a traditional lesson. Then he should think about what content he would implement with the students in the lesson and which he would assign as home exercises. Now, planning is made to help students assimilate the content

themselves that the teacher would normally pass on to the lesson. This is a key element for the success of an flipped lesson. The teacher is looking for reliable sources or wonders how to prepare the materials by himself.

2. **Presenting the topic, problem question, purpose of classes to pupils (preceding lesson)**. From the very beginning, the teacher should explain to the pupils in an accessible way what the flipped lesson is about, indicate its advantages and encourage active participation. The teacher has the idea for the teaching process and its empowerment in the program.
3. **Assign students to work at hom**e. Tasks for students:
   - preparing for lessons at home or (if they do not have access to a computer and the Internet) at school,
   - getting acquainted with materials prepared by the teacher before (e.g. watching educational films),
   - answering the teacher's questions.

   The teacher should make sure that the instructions for students about what and how they need to prepare have been understood by everyone.
4. **Students acquire knowledge on a given topic by themselves (work of students at home)**. This is a key stage of work. Students work independently in a fixed manner with the teacher. They can work individually or in teams, usually outside the classroom (here it is worth encouraging them to use ICT). They use the materials prepared by the teacher, they can also create their own base of interesting links to pages and share them with the rest of the class by creating open documents on the web.
5. **Organizing students' messages, verifying them and using them in tasks (lesson)**. This stage is already necessary in the presence of a teacher, preferably in the classroom. Students should be given the chance to verify their own knowledge and assess the level of understanding of the material. Under the supervision of a teacher, they present what they have learned, perform tasks, experiments, etc.



7.1.2. Educational resources

There is no single flipped clasroom model – this term is widely used to describe almost every lesson, the structure of which is based on watching recorded materials (movies) and, after that, classroom exercises. In addition to films, the model involves the use of interactive quizzes or exercises to check students' assimilation of knowledge. Immediate feedback for the quiz and the ability to repeat parts of the lesson make it easier to solve incomprehensible issues. The teacher can lead discussions in the classroom or supervise group work so that students use what they have learned while watching the film. In addition, the teacher proposes various approaches to the issue and monitors student progress. Due to the fact that flipped clasroom is a comprehensive change in the style of conducting lessons, some teachers decide to implement only a few elements of the inverted model or "reverse" a few selected lessons in a semester.

In the initial process of introducing the method, the teacher must devote a lot of time to preparing and developing materials and data for students. We can prepare our own: record videos, create presentations, collect text documents and share them using websites and platforms such as YouTube, Vimeo, Moodle or Fronter, in the tab on the school website or in tools using cloud technology, such as OneDrive, Google drive, Dropbox. We can also use ready-made materials – made available by the publisher of the textbook, posted on educational sites, on YouTube channels. In this case, pupils and students must receive precise information about what to use in preparation for the lesson and where they will find this material.

In order for the method to be effective, the teacher must first search or prepare various teaching materials for the lesson and make them available to students online. They can be movies, animations, articles, presentations, audio materials, interesting websites, applications, etc. Students, after having familiarized themselves with the contents of multimedia resources, should take notes, answer our questions, perform

simple exercises. At school, we can start the lesson by briefly discussing the work done by students. Then we divide the students into groups according to the degree of mastery and understanding by them of the content learned at home and assign them tasks to consolidate and expand knowledge, individualizing the learning process. Each group can work at its own pace and return to multimedia materials, playing them through smartphones. The teacher during the lesson serves each group as an expert, answering students' questions and setting further goals for them. While working at school, work cards, brainstorming, debate, exercises using iconographic materials, SWOT analysis, WebQuest, etc. will be perfect.

However, it is best to prepare the didactic video yourself – then we guarantee that students will learn the exact content that we care about most. After recording the video, we should share it on the web for students. We can use any platform for this purpose, e.g. YouTube, Edmodo, Google Classroom.

7.1.3. Technologies used

Modern technologies are not necessary, but they are extremely important and helpful in working with the flipped method. What is the essence of a traditional lesson - its content, the teacher must communicate to students in advance, in an accessible and understandable form. If the lesson is sometimes to be used for practical checking of knowledge (e.g. conducting an experiment, solving equations), knowledge that the teacher would pass in the lesson in the form of a lecture, can for example record on a dictaphone or camera (or search for such material, previously created by someone) and send it to students via email.

The tools that will help us prepare reverse learning are:

- TedEd – creating lessons based on video - tasks, discussions, additional materials,
- EDpuzzle and PlayPosit – creating interactive videos (adding notes, quizzes, including posting multiple choice questions),
- LearningApps and Educaplay – a mine of various quizzes, generators and applications (probably there is no type of puzzle that is not there),
- Screencast-O-Matic – recording - ripping an image from the desktop of a computer with the Windows operating system installed (works well when creating training sessions, tutorials or presentations),
- Platforms for creating interactive groups and classes with the ability to add tasks, attachments and monitor student progress: Edmodo and Schoology,
- Google Drive,
- Padlet,
- Pinterest,
- Google Drive,

- Blendspace,
- Nearpod,
- Seesaw,
- Pearltrees,
- Interactive quizzes: Kahoot, Quizizz, Quizlet.

7.1.4. Learning topics and places

An inverted class model may be applicable at all levels of education, for all subjects that are taught at school and universities and in both science and humanities, for a variety of subjects related to these subjects.

The teacher involved in the organization of such work should remember the following:

- all educational videos or educational electronic resources should be accompanied by clear learning objectives and step-by-step instructions,
- after recording the lecture, it is necessary to complete tasks (it can be suggested that questions will be prepared either of a general or specific nature),
- constantly engage students in writing small notes or video lecture notes.

The main aspects of the flipped pedagogy model contains a number of requirements imposed by the education system for this technology:

- use of technological tools by students, as well as personalization of the educational space in order to deepen knowledge,
- students' understanding of the specifics of acquiring knowledge in the digital world and their use of only legal and safe methods,
- use of critical thinking by students in the study of the material,
- knowledge of new topics when acquiring skills in solving problems.

7.1.5. Communication channels

During traditional lessons, students focus on what has been said at the moment and do not always have the opportunity to think for a long time about the essence of the teacher's question. Therefore, significant content related to the topic may be missed.

In the flipped clasroom model, short videos allow students to work at their own pace, rewind, review material several times and skip obvious passages, so focus on what they do not understand. This means that students come to lessons prepared for creative collaboration with peers. This is particularly important for students with special educational requirements (e.g. students with dyslexia, dysortography) who work in class conditions slower than others.

The use of an flipped lesson also allows the teacher to more easily catch repeated errors in students' thinking and correct them. Imagine a math lesson in early school

education: the teacher sent a homework video with instructions on multiplication on his fingers. The next day in class, it is easy to see if the student has correctly understood the instructions and can immediately lead the student to the correct calculation.

Due to the fact that the flipped clasroom gives the opportunity to equalize the level of students' skills by sending material to work earlier, the use of lesson time in this model is more effective. Students can learn from each other. We refer to the above example of maths lessons. The teacher can ask students to work in pairs during classes, where one student gives the partner an equation to calculate, and then checks the correctness of its implementation. Then the roles turn around. In this way, students have the opportunity to jointly acquire and test knowledge. An additional advantage of using the model can be seen in situations when the student is absent from the lesson – he has the opportunity to work at home based on the sent, ready-made material.

7.1.6. Usability condition

The flipped classroom is an innovative technology allows students to develop the qualities that are simply necessary for a person in the 21st century at school, work and life. Among them are:

- innovation and creativity,
- ability to solve problems,
- cooperation and interpersonal skills,
- ability to use information,
- ability to adapt in all situations,
- mental flexibility,
- ability to use ICT,
- independence and initiative,
- responsibility and leadership.

The usability conditions of flipped class lessons are:

- teachers have more time to help students and explain the sections that have caused self-education difficulties,
- compulsory homework for all students, because the practical part will be done in the classroom with the support of a teacher,
- no embarrassment and embarrassment for children who need to review the same material several times to finally understand it (students write down questions that arose at home, and at school the teacher also examines them),
- an opportunity for the teacher to organize his activities at a higher level, involving children in the classroom in various types of work,

- taking advantage of the Internet opportunities that allow you to communicate with children, which contributes to shaping responsibility for their education, developing critical thinking, and intellectual abilities.

7.1.7. 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

The rapid development of technology in this age caused an increase in saturation with computers and electronic devices that began to take over the functions of computers. Many of these devices remain in the hands of students 24/7, and they come to school with these devices. However, in order for these mobile devices to constitute teaching aids, they should be part of the solution that we call mobile educational technology, or shorter mobile technology, which will be used to implement mobile education (or otherwise, distance learning), i.e. one that can take place in any anytime and anywhere (anywhere) where students and teachers would like to continue their education, this could be a place at school, a family home, or other places.

M-learning means mobile learning using portable, wireless equipment such as laptops, palmtops, as well as modern mobile phones, so-called smartphones. All these devices, in order to meet the requirements of m-learning, should have permanent, wireless Internet access in every possible place.

7.2.1. Activities/phases of teaching model

The mobile learning model can be characterized by the following postulates:

1. The emphasis is shifting from teaching to learning.
2. The transition from teacher centered to learner centered is made, i.e. the student becomes the main subject of education.

3. It enables far-reaching personalization, manifesting itself in the possibility of creating individual learning environments and paths.
4. The learner collects his individual resources in a personal archive and can create e-portfolios based on them, which are material for reflection on his own education and development.
5. It contributes to the implementation of the idea of learning anytime and anywhere, i.e. learning at any time and in any place, which requires, however, the conscious commitment of the student.
6. The learning process can be asynchronous (not all students learn the same at the same time) and dispersed (it takes place in different places and at different times).
7. The education system is based on constructivist ideas, i.e. the building and development of knowledge by students in the real environment of their residence and development.

7.2.2. Educational resources

Mobile devices are great for both preparing and playing a wide class of multimedia presentations consisting of a series of images, animations, transition effects, video and possibly accompanying sound. A simple and effective presentation can be a series of properly arranged graphics and text – the so-called the slideshow. This presentation can be played using virtually any mobile device, including cheap mobile phones, and even pocket players or so-called digital photo frames. Therefore, it is best and easiest to consider as a standard of presentation for mobile devices a show of a series of properly arranged photos or graphics. Another solution is to use online presentations previously created in Google Docs.

7.2.3. Technologies used

Mobile devices are only part of educational mobile technology, which consists of four elements:

1. mobile (portable) devices with the function of a computer with wireless Internet access; such devices enable the use of the Internet, as long as they have access,
2. wireless Internet access – in many places at school, as well as in student homes, Internet access can also be wired,
3. a virtual learning environment - this is the most important element of mobile technology – it is used to organize the learning process and store individual resources of students and teachers and is available at any time from any place with access to the Internet; a special case of such an environment is the educational platform; in general virtual learning environments are located in

the cloud computing to allow free access to them from free space as soon as there is access to the Internet,

4. organizational adaptation of the use of the above elements 1-3 for educational purposes at school and at student homes.

Using the application for smartphones and tablets, thanks to these devices you can, among others: use the office software (word processor, spreadsheet, presentation editor):

- read electronic books and audiobooks,
- play music and even movies,
- create mind maps,
- browse the internet (watch YouTube videos, post blog posts, look up information on Wikipedia, even run a portal),
- use messengers such as Gadu-Gadu, Google Talk or Skype.

The camera built into the mobile device has numerous educational advantages:

- the quality of the materials obtained is sufficient for virtually all teaching applications,
- the small size and weight of the smartphone allows you to take pictures or videos in conditions that would be difficult to obtain using standard equipment, e.g. by small holes, slots, on improvised outriggers,
- universal availability anytime and anywhere – allows recording live events, actions, according to good reporting patterns,
- recorded materials can be played back (sometimes and edited) directly in a mobile device,
- recorded materials can be sent immediately between devices (e.g. via Bluetooth) or publish on the internet (e.g. via WiFi or MMS).

7.2.4. Learning topics and places

DOJO CLASS, https://www.classdojo.com/pl

A free application available in Polish that connects teachers with students and parents to create a school class community. Teachers can share tasks and resources such as photos, videos, classifieds and messages in the application.

EDUPUZZLE, https://edpuzzle.com

A simple platform that, in addition to video resources from various thematic areas, allows teachers to communicate with students through virtual classrooms.

KHANA ACADEMY, https://www.khanacademy.org/

A huge resource of educational videos on YouTube, an online tool and a mobile application for learning and solving tasks (mostly available in Polish).

LEARNING APPS, https://learningapps.org/

Free website with interactive subject exercises available in Polish. Creates the ability to add your own resources, also by students. You can also create a virtual class.

ViaMichelin Local, https://quizizz.com/

Is a free platform that allows you to create and run quizzes.

TED ED, https://ed.ted.com/

English-language (but with Polish subtitles movie channel) supporting the education of children and youth and allowing to create animations about curiosities and scientific news or with logical puzzles.

B-Learninig, https://epodreczniki-zawodowe.blogspot.com/

Educational materials for vocational education. Each of the professional platforms consists of thematic modules, corresponding to the next topics of program sections. In individual modules, sets of e-textbooks displayed directly on the website and repositories, videos and presentations illustrating the content of the e-textbook have been made available. In addition, users have a lot of supplementary materials at their disposal, such as guides, scripts, exam sheets, proof tests and other useful resources.

7.2.5. Communication channels

MICROSOFT OFFICE 365 A1, https://news.microsoft.com/pl

Free Microsoft service that enables students to study remotely. Materials and assignments can be made available online, and pupils, students, teachers and lecturers collaborate using remote messengers that allow both group and individual work.

Discord, https://discordapp.com/

Discord provides: a dedicated, free and accessible only by invitation classroom, text channels for organizing lessons, homework or creating student groups, voice channels for face-to-face conversations, group discussions and even roster, real-time educational environment in which lessons for 50 people can be taught.

ZOOM, https://zoom-us.pl

Online meetings, video conferences, webinars, teleconferences, conference rooms – Zoom.

7.2.6. Usability condition

The virtual role is played by a virtual learning environment located in the cloud and containing all elements to which all actors want to have access in the theater of education. These elements are equally the individual resources of students and teachers as well as the system of education organization in which students and teachers work. An educational platform (e.g. Fronter) can be such a system. In addition, all other resources (such as foreign educational resources or access to them, e-textbooks, e-portfolios, project environment, e-journal and others) should be located in this environment and should be flexible enough, to enable the implementation of traditional class-lesson

classes, as well as any forms of educational activity of students and teachers, entire classes, schools, as well as groups of students or teachers also formed ad hoc within one school and above schools.

The educational advantages of the virtual learning environment include:

- Improving the quality of independent and personalized learning. Materials and course of education can be tailored to the individual needs of learners.
- Increased opportunities for collaboration and interaction, including out of school.
- Expanding and enriching digital literacy – students will learn the mechanisms of work and collaboration environments that are today used in every organization and corporation.
- Supporting students with special educational needs (for example, the Pro-myk Foundation project carried out in Wrocław using the Fronter platform).
- Increasing the level and scope of educational materials, by making them public in the learner community, and by the possibility of continuous correction and improvement.
- Improved teacher time management, so that they can devote more time to students.
- Better monitoring of student and teacher work by school staff and the principal.
- Increasing the participation of students in their own education, which is accompanied by a personalized place in the virtual environment.
- Improving the organization of education and communication, also saving some other materials such as paper, textbooks, other books.
- Better management of the entire school, both from the administrative and educational side. School management capabilities in larger administrative areas.
- Increased parental involvement due to access to their children's places in a virtual environment.
- Building a learning community through greater participation of students in creating it.

7.2.7. 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

Virtual Reality (VR) and Augmented Reality (AR) systems combine the image of the real environment (seen by man) with computer generated information. This information can take the form of text, sounds or images, and can even be three-dimensional objects. They are generated on the basis of the location in the space determined by the VR/AR

system (using a built-in compass, gyroscope, GPS, etc.) and recognized objects visible in the lens of the digital camera.

The educational potential of augmented reality is primarily based on the possibility of creating illustrative, very realistic teaching aids. This allows teaching materials that are difficult to access for financial or logistical reasons, or for safety reasons (e.g. conducting chemical experiments) to be used in teaching. The health benefits of augmented reality should also be emphasized. Programs using AR enable (and much more often force) the user to move, frequent changes of body position. Even a regular computer game instead of chaining to a chair and screen – engages the user with intense movement that controls the game, moving the whole body, jumping and even running with a tablet or smartphone in hand.

The latest scientific research clearly confirms that when a person is better involved in a given message – he is able to absorb knowledge much faster and more effectively. In the case of using virtual reality in education, an average increase in content retention at the level of about 50% compared to the methods known so far is observed. This is influenced not only by the possibility of being in the VR/AR world, but also by interacting with objects and elements of the virtual world.

Virtual reality is the so-called native medium. No other medium (neither radio nor television, cinema or internet) allows such a degree of involvement as when using VR. In the world of virtual reality, we move in exactly the same way as in the real world. Depending on the type of application and equipment we have – we can move freely, pick up objects, drop them, etc. With experience in the VR world we enter exactly the same interactions as in the real world. We are 100% committed to this world. Therefore, using VR in education, we can engage the viewer much more effectively, which translates into better understanding and remembering the topic.

7.3.1. Activities/phases of teaching model

The steps of creation process of Virtual/Augmented Reality applications:

Step 1. Clarification of the final concept of the VR/AR application

When creating an VR/AR application, at the initial stage - before we even sign the contract - we need to know how the application will work. Therefore, it is extremely important to clarify the concept properly. This is done initially at the first valuation stage. Then, when adding the details of the contract – we determine the final application scenario.

Together with the client we determine step by step what the user will do, what he will be able to interact with and what will happen on the screen of the device as a result of these interactions. It is equally important to determine where the data, 3d models, photos, videos and other materials displayed in the application will be downloaded from.

As part of the concept, we also determine the appearance of the application, the appropriate template, colors, appearance of icons, sounds, etc. The more issues we determine at this stage, the easier it will be for both parties later.

Step 2 Choosing the right engine for virtual/augmented reality

The VR/AR engine is actually what a word processor is, for example, when we write a book. It allows us not only to create the entire application that will work properly on various devices, but also guarantees the possibility of its use, expansion, data exchange with the user, and much more.

When creating VR/AR applications, we use the Unity environment. At Unity – depending on which platform we create – we use various additional engines.

Step 3 Preparation of graphics and 3D models for the VR/AR application

This is a very important stage. The success of the VR/AR application depends largely on it. By using ready-made 3d models purchased from banks or publicly available databases, we run into problems with optimization. It is much more reasonable to model from scratch, for another project. Of course, this is associated with higher costs, but in the end it gives us a guarantee that the application will run smoothly and will not hang or jam.

When creating 2D graphics, things are simpler. They do not burden the performance of the device as much. What's more, there are already repeatedly tested tips that clearly show what interface arrangement is beneficial for the user. Based on scientific research, we are sure that the application not only meets current trends and guidelines, but above all that the fruit of our work will be pleasant and easy to use.

Step 4 Programming works – writing, creating and programming VR/AR applications

We sometimes enter this stage simultaneously when graphic designers are already working on 3D models and 2D graphics. Usually, we start programming work by developing the application logic and testing the assumed functionalities. At this stage, we already have the VR/AR engine selected, so we also have programming available at our disposal. Most often, we start with work on the so-called "Backend" or everything that the user cannot see, but without which the application will not work. When we already have a set of graphic materials, we are already creating a "frontend", which gives us at the first stages the opportunity to check how the finished application will look.

Programming works are accompanied by parallel internal tests. Each new functionality must be tested very thoroughly in many different ways, on many devices, under different circumstances. At this stage, we try to cause all possible errors that could be encountered by the user.

Step 5 External tests performed by the client and project finalization

After the programming work is over, it is time for the client to test the application. At this stage, we try to cause various possible errors, which we then solve. We do not want users to be testers of our solutions. Although sometimes it happens that someone

in the store after downloading the application will write a short comment about the fact that something is not working – such situations are rare with us. We spend hours testing to eliminate all possible hypothetical errors.

Step 6 Tutorials, guides, promotional materials.

When creating applications, we usually publish it in the appropriate store. Hence, we must prepare promotional materials, graphics, descriptions for the store. At this stage, we also add tutorials and guides to the application itself that will make the user navigating the application much easier and smoother.

7.3.2. Educational resources

The simplest AR software are games in which virtual objects are superimposed on the display screen on the camera image. In educational applications, AR software bodes well, which recognizes the objects seen by the camera and attaches an additional information layer to their image on the display. As a result, the user (here: student) receives information presented in an attractive, motivational and very demonstrative way. Visual search of information using AR software does not yet give such precision that can be achieved by text search8. However, it largely makes up for these limitations and the shortcomings of small screens and uncomfortable keyboards, replacing them with an enthusiastically accepted level of visibility by both students and adults.

An example of the so-called the visual search engine using AR is Google Goggles embedded in the Google mobile search application. The program searches information on the Internet based on photos. Can recognize many objects, e.g. architectural objects, works of art or book covers. The application also allows you to save paper business cards in the form of telephone contacts, translate foreign language texts, read QR Code or even solve Sudoku.

Another visual search engine is the Wikitude application. The user views the environment on the tablet / smartphone screen indirectly – through the built-in camera. Wikitude puts additional information about the world seen on the observed image in real time. For this purpose, the application uses the built-in compass and GPS module (for locating and recognizing objects in the field of view) and the internet connection (to search for information on recognized objects). This information can be in the form of Wikipedia articles, YouTube videos or photos from Panoramio. On the Wikitude website you can also create your own descriptions of objects that every user of the application will see at home.

7.3.3. Technologies used

Currently, every modern smartphone, tablet or game console allows you to run applications (even games) using VR/AR systems.

To run a simple augmented reality system, you need a device equipped with:

- a GPS receiver,

- a compass,
- a camera on the back (opposite the screen),
- mobile internet access.

Specialized software for recording with mobile devices has much wider possibilities than standard word processors. Choose applications that allow you to create notes in the form that is most convenient for your situation: typed text, handwritten text (on the touch screen), dictated text (with speech recognition), sound recording, photos or video recording.

Entries can also be made by reading bar codes or surface codes (QR) using the device's camera. It is worth noting that such notes can be very valuable, because flexible, multimedia teaching aids for students. The student can adjust the form of recording to the needs of the situation as well as to the preferred cognitive style (visual, auditory, tactile, kinesthetic). The student can always have an unlimited number of such notes in his pocket and reach out if necessary. It is quite probable that he will look at them, e.g. by bus to school or waiting for a friend in front of the block.

7.3.4. Learning topics and places

Modern smartphones and tablets are equipped with specific peripherals, thanks to which they are perfect as hand-held measuring and recording devices. A typical set of peripherals (interfaces) of a modern smartphone is surprisingly rich: camera, video camera, microphone, speaker, bluetooth, GPS, compass, accelerometer, touch screen, WiFi.

After installing easily available applications that use these interfaces (often in a very ingenious way), we will receive a professional, mobile research laboratory. Some quantities can be measured with high precision (e.g. acceleration and its components), others only as approximate relative quantities (e.g. brightness measurement). Still other quantities are obtained thanks to the ingenious combination of the features of several sensors at the same time (e.g. measuring the height of distant objects using the triangulation method).

In educational applications, the total measurement and registration capabilities exceed those that we could count on in a good school laboratory. Here is a (incomplete) list of measurement possibilities (including the possibilities of a standard equipped device supplemented with generally available software, without external measurement interfaces):

- brightness,
- sound intensity,
- acceleration (broken down into spatial, component, Cartesian),
- gravitational acceleration,

- height above sea level,
- geographical location (coordinates of longitude and latitude),
- heart rate (by stethoscope and photoelectric method),
- length (using detecting and measuring the movement or rolling of the entire smartphone or tablet),
- distance (fishfinder),
- height of distant objects (automated triangulation),
- WiFi signal strength,
- presence of metal,
- magnetic field,
- geographical direction,
- bandwidth and delay.

A trip with a tablet or smartphone is much easier to organize than a trip with a set of traditional measuring instruments. Therefore, below are examples of specific measurement applications, available only for mobile devices and not suitable for implementation in the classroom.

Example 1. Tour route

During the tour you will need a mobile device equipped with a GPS receiver and a program to record the route. The data format allows it to be later applied to Google maps for further analysis. To this end, Google Maps offers many measurement and visualization tools. In addition to the simplest use of such a route record (documentation and visualization of the trip), one can base on it a number of educational fruitful activities related to geographical considerations (using the map, analysis of cartographic coordinates in real applications, analysis of concepts, facts and geographical and sightseeing phenomena based on the photographic layer – satellite images – Google maps, etc.), mathematical (route comparison, optimization, approximation (estimation) issues, distinction between road and distance concepts, also analytical geometry based on geographical polar coordinates or simply on coordinate systems drawn into a Google map).

Acceleration measurements can be carried out in a physical laboratory as an extension of traditional methods. It is enough to install the appropriate software for measuring, recording and visualizing data from the internal sensor in a mobile device. Instead of a calculator, a ruler and a stopwatch to measure the acceleration of the slide down the incline, you can use a smartphone attached with adhesive tape. Much more demonstrative, motivational and well – health-promoting – experiments can, however, be conducted using a smartphone and a real bike (e.g. measuring acceleration when starting or braking). Centripetal acceleration measurements can be carried out on a ... carousel. The tasks may then relate to the highest acceleration obtained and its

dependence on the time of one turn, but also, for example, to ... the number of people setting the carousel in motion and the number of people sitting on the carousel. They can be compared with the results from another carousel and draw very interesting conclusions.

7.3.5. Communication channels

Virtual reality currently offers two types of experiences:

- interactive VR applications
- and 360 movies.

VR applications are created like computer games and allow us to virtually limitless space exploration and interaction with objects. An example of this type of solution is VR application for learning forest ecosystems. 360 movies are real-world images recorded using 360 cameras. They have a much higher level of realism than VR applications, but offer much less opportunities to expand interactivity.

In virtual reality without any risk we are able to take any number of training participants to the most dangerous places in the world. Everyone up close can observe dangerous phenomena or undergo training in places where he could not be in the real world.

Using virtual reality in education - e.g. in the area of historical themes, we can take the viewer to ancient Greece and let him face the characters and heroes from several thousand years ago. Users can interact with these people, explore places that no longer exist, and perform any activities that the developers have planned.

7.3.6. Usability condition

When using virtual reality in education, remember the following:

- The most important thing is the realism of the phenomena presented. If we create any VR educational experience, we must map it at least as accurately as it occurs in the real world. Thinking seriously about using virtual reality in education, you need to take into account primarily the level and quality of experience. Only then can we talk about effective substantive education.
- Virtual reality is a completely new medium that is governed by its own laws. In the case of the tools used so far in education (movies, illustrations in books) we have always had to deal with a flat image that was located some distance from us. In virtual reality, the image surrounds us from all sides. Therefore, the perspective in which we absorb knowledge changes. The way in which this knowledge is given is changing.
- Virtual reality allows you to map virtually any process and every event at any time. Thus, VR solutions have virtually no restrictions. When using VR in

education, it is worth thinking carefully about the content we want to create and transfer to the world of VR the most surprising and engaging scenarios. This is a new medium that is currently being developed by industry pioneers. Everything is allowed so that it serves the end user.

7.3.7. 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

In the field of edtech, technology often tends to take precedence over education, meaning that solutions are implemented without appropriate consideration and scrutiny of the pedagogical context within which they will be applied. This leads to the failure of many initiatives, because regardless of the transformative power of any one technology, its effectiveness inherently depends on coherent deployment as part of a broader strategy. This is evident in the education sphere, where success is invariably linked to effective engagement with educators, and to building responsive feedback loops that prioritize learning outcomes. Research has shown that the most effective educational experiences are those designed around social constructivist learning approaches, which involve mastering authentic tasks in the context of personally relevant, realistic situations.

This is something that immersive technologies are particularly well-suited to provide. Simulations allow learners to not only recreate and practice routine situations, but also to access experiences which would be out of reach – due to difficulty, expense, danger, or sheer impossibility – in real life. Their effectiveness, however, hinges on the ability to create conditions where the learner feels truly immersed in an environment and narrative, replicating the impact of a real-world experience.this paper explores various ways immersive technologies, such as mr, can impact learning outcomes – for example, reducing the cognitive load on the brain by allowing direct, first-person visualization of complex ideas and structures. This not only dramatically increases student engagement, but also enables learners to assimilate complex information more efficiently and retain it for longer. Perhaps most important, this is achieved within a holistic context that significantly increases the rate of transfer (i.e., the ability to successfully adapt and apply what is learned in a variety of real-life scenarios). This transfer takes place because technologies such as mr can leverage immersion to successfully simulate a variety of realistic scenarios within specific pedagogical contexts.

8.1. Flipped Learning

While often defined simplistically as “schoolwork at home and home work at school,” Flipped Learning is an approach that allows teachers to implement a methodology, or various methodologies, in their classrooms.

To counter some of the misconceptions about this term, the governing board and key leaders of the Flipped Learning Network (FLN), all experienced Flipped Educators, have composed a formal definition of “Flipped Learning.”

Flipped Learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter.

These Flipped Learning leaders also distinguish between a Flipped Classroom and Flipped Learning. These terms are not interchangeable. Flipping a class can, but does not necessarily, lead to Flipped Learning. Many teachers may already flip their classes by having students read text outside of class, watch supplemental videos, or solve additional problems, but to engage in Flipped Learning, teachers must incorporate the following four pillars into their practice.

8.1.1. Activities/phases of teaching model

There are numerous ways to flip a classroom but some of the following strategies can help:

Set pre-lesson content and material that is engaging. Assuming that all pupils will read challenging, lengthy texts or complete detailed research from vague instructions

may be unrealistic. Tasks should raise questions, spark interest and have clear, attainable goals that students can reach independently.

Make use of technology. Many flipped-learning teachers use videos and online resources to create a form of tutorial outside of designated lesson time. This leaves them free to engage with students individually and provide support and extension more effectively when back in the classroom as they are not leading from the front.

Set up expectations before flipping the learning so that all students know what they will be required to do and produce. Effective flipped learning happens with pupils who are comfortable with the process of studying independently and have clear structures to follow. Teachers should model desired approaches to research and note-taking and teach pupils how to go about tasks before sending them off to complete them individually.

Make students accountable and ensure that the expected work has been completed by building in comprehension tests or informal assessments. Simple tests of learning can be set via online programmes for students to complete prior to the lesson, or starter activities that make use of knowledge from independent study might be used to gauge the level of work completed (or, more importantly, the range of understanding across the classroom).

The Four Pillars of Flipped education

Flexible environments - Flipped Learning allows for a variety of learning modes; educators often physically rearrange their learning spaces to accommodate a lesson or unit, to support either group work or independent study. They create flexible spaces in which students choose when and where they learn. Furthermore, educators who flip their classes are flexible in their expectations of student timelines for learning and in their assessments of student learning.

Learning culture - In the traditional teacher-centered model, the teacher is the primary source of information. By contrast, the Flipped Learning model deliberately shifts instruction to a learner-centered approach, where in-class time is dedicated to exploring topics in greater depth and creating rich learning opportunities. As a result, students are actively involved in knowledge construction as they participate in and evaluate their learning in a manner that is personally meaningful.

Intentional content - Flipped Learning Educators continually think about how they can use the Flipped Learning model to help students develop conceptual understanding, as well as procedural fluency. They determine what they need to teach and what materials students should explore on their own. Educators use Intentional Content to maximize classroom time in order to adopt methods of student-centered, active learning strategies, depending on grade level and subject matter.

Professional Educators - The role of a Professional Educator is even more important, and often more demanding, in a Flipped Classroom than in a traditional one. During class time, they continually observe their students, providing them with feedback relevant in the moment, and assessing their work. Professional Educators are reflective in their practice, connect with each other to improve their instruction, accept constructive criticism, and tolerate controlled chaos in their classrooms. While Professional Educators take on less visibly prominent roles in a flipped classroom, they remain the essential ingredient that enables Flipped Learning to occur.

8.1.2. Educational resources

Media Education Guidance is an educational procedure set out to empower citizens to experience today's 'communicational ecology' with a critical and interventionist spirit. It aims at harnessing the resources and opportunities that media and communication networks provide to enrich personal and social development, so that every person can live, learn and work with more quality. This document aims to propose a frame of reference for the pedagogical work on media education issues in preschool education and primary and secondary schooling, taking analogous documents from other countries as a reference, as well as the recent positions of European and international institutions. It involves addressing issues such as: conditions and opportunities to access technological equipment and applications; diversity and media use rules; ability to seek, assess and select relevant information, to critically analyse it and significantly apply it to the needs of every day's life; ability to better communicate with others. As media consumers, citizens are faced with ever-greater challenges due to the quantity and diversity of data and information, which increasingly require accurate and sophisticated literacy levels in this area. In Portugal, as it happens in other European Union Countries and the Organisation for Economic Cooperation and Development (OECD), Media Education Guidance should be regarded as lifelong education, a process for which formal education is a key word.

APPS for Good (since 2014) "Apps for Good" is an open-source technology education movement that partners with educators in schools and learning centres to deliver courses to young people 10-18 years of age. Middle school and high school students work together as teams to find real day-to-day issues (e.g. energysaving; food supply) they care about and learn to build a mobile, web or social app to solve them. The main purpose is to secure students' spontaneous expression, the search for original, diversified and innovative solutions to problems, the selection of tecniques and instruments with persuasive intent and participation in the process of technological creation. The teams are supported by two teachers, who act as facilitators, while students share their ideas and clarify any doubts through video conferences with experts from Portugal and India. Teachers and students, with or without an IT background, have

access to a platform where subjects are organised in different modules, videos and class tutorials and materials that will help them build an app.

Jornais Escolares - School Newspapers (since 2013) This initiative serves of a platform of dissemination, content sharing and peer learning. Teachers and educators can upload download and share educational material, school newspapers and lesson plans staring from preprimary to high school inclusing vocational training. The idea behind this platform is to provide teachers, students and schools with knowledge and tools that will enable them to create the digital edition of their newspapers. School newspaper project coordinators may register using the form available in order to cover various the school clusters.

Khan Academy Created in 2006 by American Salman Khan, the Khan Academy website, now adapted to the Portuguese curricula, and made available by the PT 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 PT 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.

8.1.3. Technologies used

Google Classroom: Teachers use Google Classroom in a variety of ways—to deliver assignments to students and to provide effective and efficient feedback, for example—and it can be a great landing page for students as they navigate assignments. At the beginning of a lesson, teachers can direct students to assignment goals, objectives, and instructions in Classroom. Classroom can also be used to distribute a lesson's digital texts and other resources.

In flipped environments where students take notes on instructional videos digitally, classroom can be used to assign a unit Google Doc to students for that purpose. Teachers can establish this procedure as a norm at the beginning of the school year so students know that they should begin each class period by going to Google Classroom.

ED-Ed Platform: The motto of TED-Ed is that they are worth being TED videos are already used by some educators as a reference source in your classes. The novelty of the platform is the possibility that the teacher or student make interventions on the video, including multiple choice or essay questions, add links to extra content and related activities. Being considered the most innovative part of the project the possibility of using the class customization tool for any video available on YouTube.

A customized lesson on the TED-Ed platform allows students to review it outside classroom, being able to learn at your own pace.

The chosen video may contain explanatory visuals that improve understanding of a subject. It can also be used as a resource made available before the student comes to class, allowing him to absorb the principles basics of that same class. The teacher gains time that can be used to research, discussion, collaboration, critical thinking and individual monitoring provided to the student**.**

Padlet: After students have viewed an instructional video, it's a good idea to provide them with an opportunity to reflect on the content. Padlet provides teachers with a way to have students not only review and reflect on content, but also collaborate with their peers.

Teachers can create a new Padlet wall for each video or unit and encourage students to ask questions and answer their peers' questions about content as a review for unit assessments. Using an extension such as Screencastify, teachers can create screencasts of the Padlet wall for their students to use as a study aid.

CISCO's Packet Tracer: The CISCO (PT) packet tracer allows students to simulate, in a classroom environment classroom, computer networks through equipment and configurations present in real situations. It is a tool that facilitates the teaching and learning of concepts technological complexes. PT allows students to create a network of computers with an almost unlimited number of devices, encouraging them to practice, discovery and problem solving. This learning environment based on simulations helps them to develop skills, such as decisions, critical and creative thinking and problem solving. Teachers allows you to easily demonstrate complex technical concepts in creating systems networks and makes it possible to personalize activities so that classes become very practical and oriented to the specific topics covered in a lesson. From this way, students can build, configure and troubleshoot networks, using virtual equipment and simulated connections, alone or in collaboration with other students.

EdPuzzle is a free assessment-centered tool that allows teachers and students to create interactive online videos by embedding either open-ended or multiple-choice questions, audio notes, audio tracks, or comments on a video. Edpuzzle interactive videos can be made with videos from several websites, including YouTube, TED, Vimeo, and National Geographic.

HippoCampus is a free, web site that delivers free videos, animations, and simulations, to secondary school teachers and their students., free of charge.

Hippocampus was designed as part of a worldwide effort to improve access to quality education for everyone. Videos are pulled in from many different places such as Khan Academy, and simulations from Phet. The content is aimed at the higher end of Secondary school and the main focus is on Maths and Science, but there are also resources for English, Religious Studies, Economics, History, Psychology and Sociology.

8.1.4. Learning topics and places

Flipping the classroom is a "pedagogy-first" approach to teaching. In this approach in-class time is "re-purposed" for inquiry, application and assessment in order to better meet the needs of the individual learners. Students gain control of the learning process through studying course material outside of class, using readings, pre-recorded video lectures (using technology), or research assignments. During class time, instructors become facilitators of the learning process by helping students work through problems individually and in groups. There are numerous ways to flip your class. In fact, "every teacher who has chosen to flip does so differently". Flipping the classroom, or 'inverted teaching' is a response to the idea that class time can be used to engage students in learning through active learning techniques, rather than through delivering lectures alone. Flipping the classroom is the process of replacing traditional lectures with more student-centered learning strategies, such as active learning, discussions, problem-based learning, and other forms of group work and peer instruction. Content delivery is moved outside of the classroom, for example, through videos, or pre-class readings.

It also creates the opportunity for differentiated roles to meet the needs of students through a variety of instructional activities. This is where the work must occur as the conversation of the flipped classroom moves forward and becomes more mainstream in public and private education. We must first focus on creating the engagement and then look at structures, like the flipped classroom, that can support in teaching and learning in several disciplines. So, educators, here are some things to think about and consider if we are thinking about or already using the flipped-classroom model.

Flipped Learning approach seeks to preserve the value of lecture (expertise and custom delivery), while freeing up precious in-person class time for active learning strategies. The main goal in flipping a class is to cultivate deeper, richer active learning experiences for students when the instructor is present to coach and guide them. Emphasis is on higher-order thinking skills and application to complex problems, and may include collaborative learning, case-based learning, peer instruction and problem sets.

8.1.5. Communication channels

Slack is a meeting space, water-cooler, bulletin board, and phone-tree for your whole organizing team. It's a great place to coordinate and collaborate, and a fun place to get to know your fellow organizers and activists, even when you can't all be in the same room at the same time. It's a tool that you can use on your computer and your phone to stay in touch with your team and keep everyone up to date with the important news and goings-on.

Slack can replace email, text messaging, and instant messaging for your team, and keep all those communication styles together in one app. With both desktop and mobile versions, Slack can help your team collaborate and coordinate their work no matter where they are — in the field office, at home, or out knocking doors.

Microsoft Teams offers several different ways to communicate with learners: Conversations (Teams — Semi-synchronous); Files (OneDrive — Asynchronous), Content (OneNote — Asynchronous), Outcomes (Planner — Asynchronous).

Conversations, files, content, and outcomes in aggregate offer forms of communication that may be synchronous, semi-synchronous, and asynchronous as well as emerging in and outside of the classroom. The reasoning for using Microsoft Teams (Teams, OneDrive, OneNote, and Planner) is to have options in the types and modes of communication so that as the course transpires, adaptations to assessment and instruction can be made as needed.

Google Drive is a file storage and synchronization service developed by Google. Launched on April 24, 2012, Google Drive allows users to store files on their servers, synchronize files across devices, and share files. In addition to a website, Google Drive offers apps with offline capabilities for Windows and macOS computers, and Android and iOS smartphones and tablets. Google Drive encompasses Google Docs, Google Sheets, and Google Slides, which are a part of an office suite that permits collaborative editing of documents, spreadsheets, presentations, drawings, forms, and more. Files created and edited through the office suite are saved in Google Drive.

Whats up: Since launching in 2009, WhatsApp has become the world's most popular text and voice messaging application. Specializing in cross-platform messaging, WhatsApp is a free service that lets users message one another seamlessly between mobile and desktop devices. WhatsApp is known for its enhanced privacy features, such as end-to-end encryption, and its free, web-based international calling. Read on to find out how you can leverage the Facebook-owned messaging giant to make free international calls.

Google Meet: Is a video conferencing app. It is the business-oriented version of Google's Hangouts platform and is suitable for businesses of all sizes and education sector, among others. Google Meet integrates with G Suite versions of Google Calendar and Gmail and shows the complete list of participants and scheduled meetings.

Khan Academy is an American non-profit educational organization created in 2008 by Salman Khan, with the goal of creating a set of online tools that help educate students. The organization produces short lessons in the form of videos. Khan Academy offers practice exercises, instructional videos, and a personalized learning dashboard that empower learners to study at their own pace in and outside of the classroom. We tackle math, science, computer programming, history, art history, economics, and more. All resources are available for free to users of the website and app.

Educreations: Is an interactive whiteboard tool that allows educators and students alike to design more enhanced and engaging presentations. On the Educreations site or iOS app, users can record, share, and view interactive lesson plans. Users can import images into their whiteboard with the free version and mark them up in real time up on a screen. This tool would be valuable for a variety of lessons. Sentence structuring, labelling diagrams, or even just playing games and tallying the score. Educreations makes the whiteboard process faster and more versatile for everyone.

8.1.6. Usability condition

In a nutshell, the traditional classroom structure revolves around the teacher lecture, which students attend by listening passively while taking notes, and are given assignments based on the material presented during the classroom. Most commonly the instructor talks about concepts from the textbook, which apparently constitute "everything" the students need to know. This is followed by exercises, usually assigned for homework, which students must complete alone.

In this structure, students are essentially procedurally bound, going through the motions without reflecting on their meaning. Consequently, the grades assigned do not take into consideration the students' skills and depth of observations.

Most specialists agree that there is more to flipping than just watching videos of lectures and doing exercises in class. A video of a lecture is still a lecture. One of the main reasons for flipping the classroom is to shift from giving preference to lecturing as the primary means of delivering content and organizing class time. The teacher can develop an excellent lecture effectively, but the instructors often rely exclusively on the lecture, and often forget or don't have time for other alternative more meaningful teaching and learning strategies.

The flipped classroom model implies a role change for both instructors and students. The active role of the teacher as the "sage of the stage", now assumes the role of a guide on the side for a more collaborative and cooperative contribution to the teaching process. Students now assume the active role in the classroom, instead of merely passive participants in the education process. The flipped model puts more of the responsibility for learning on the students, in which activities are student-led, and student communication become the determining dynamic in class, through hands-on work. In terms of learning, there is a distinct shift in priorities from just covering material to mastering it.

By flipping the classroom, an instructor intentionally designs a flexible experience to engage students in asynchronous online learning followed by synchronous active learning during a scheduled class time. Thus, within this new lens, and student-centered perspective, and more efficient use of class time, teachers are now free to create their own Flipped Classroom version.

8.1.7. 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

Mobile learning, also known as m-learning, is a new way to access learning content using mobiles. Mobile learning supports, with the help of mobile devices, continuous access to the learning process. This can be done using devices like your phone, laptop or tablet. You can learn wherever and whenever you want! With the advent of mobile learning, educational systems are changing.

The term M-Learning or "Mobile Learning", has different meanings for different communities, that refer to a subset of E-Learning, educational technology and distance education, that focuses on learning across contexts and learning with mobile devices. Mobile learning has many different definitions and is known by many different names, like M-Learning, U-Learning, personalized learning, learning whilemobile, ubiquitous learning, anytime / anywhere learning, and handheld learning. One definition of mobile learning is, "any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies" (MOBIlearn., 2003). In other words, with the use of mobile devices, learners can learn anywhere and at any time (Crescente and Lee, 2011). Mobile learning is considered to be the ability to use mobile devices to support teaching and learning.

Mobile learning‘ is certainly not merely the conjunction of mobile‘ and learning‘; it has always implicitly meant mobile E-Learning‘ and its history and development have to be understood as both a continuation of conventional‘ E-Learning and a reaction to this conventional‘ E-Learning and to its perceived inadequacies and limitations. It is the

mobile' aspect of mobile learning that makes it stand apart from other types of learning, specifically designing learning experiences that exploit the opportunities that mobility' can offer us. M-Learning focuses on the mobility of the learner, interacting with portable technologies, and learning that reflects a focus on how society and its institutions can accommodate and support an increasingly mobile population.This is because mobile devices have features and functionality for supporting learners. For example, podcasts of lectures can be made available for downloading. Learners are to expect to engage with these learning resources whilst away from the traditional learning spaces.Over the past ten years mobile learning has grown from a minor research interest to a set of significant projects in schools, workplaces, museums, cities and rural areas around the world.

8.2.1. Activities/phases of teaching model

Mobile devices, and their technologies and systems, are eroding established notions of time as a common structure that had previously underpinned social organization and the consensual understanding of the world.Time-keeping is being replaced by the approx-meeting‘ and the multi-meeting, socially negotiated time, the micro coordination of everyday life‘ alongside the softening of schedules afforded by mobile devices, with the mobile phone, time has become personalized. Whereas previously our social and business relations had to be organized and synchronized by absolute clock time, now mobile technologies allow us to renegotiate meetings and events onthe-fly.However, Basic mobile phone features are: Making and receiving calls; Sending and receiving text messages; and Basic office tools e.g. calculator.Advanced mobile phone features include: Bluetooth; Camera capable of taking stills and more commonly now video; e-book readers, games; Recording audio; GPS / location aware; and Web browser to connect to the internet. Mobile learning can happen anywhere: in a classroom, at the dining room table, on a bus, in front of a science exhibit, and anywhere. Portability is not as important as the ability of the learner to connect, communicate, collaborate, and create using tools that are readily at hand. We have got them working as part of the M-Learning project. We are using the seductive power of these new technologies to re-inspire young learners who are dropping out of traditional learning. Research and development have been ongoing for the last two years and many learners have already been trying out these approaches and contributing to their development.

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8.2.2. Educational resources

APPS for Good (since 2014) is an open-source technology education movement that partners with educators in schools and learning centres to deliver courses to young people 10-18 years of age. Middle school and high school students work together as teams to find real day-to-day issues (e.g. energysaving; food supply) they care about and learn to build a mobile, web or social app to solve them. The main purpose is to secure students' spontaneous expression, the search for original, diversified and innovative solutions to problems, the selection of tecniques and instruments with persuasive intent and participation in the process of technological creation. The teams are supported by two teachers, who act as facilitators, while students share their ideas and clarify any doubts through video conferences with experts from Portugal and India. Teachers and students, with or without an IT background, have access to a platform where subjects are organised in different modules, videos and class tutorials and materials that will help them build an app.

MOBILE LAB is a project developed by Vodafone Portugal in partnership with INOV-INESC, the Directorate-General for Education (DGE) and the Directorate-General for Health. This project is based on the development of a set of multimedia content, supported by a microsite, which, with the context of mobile communication systems, develops content from the Mathematics and Physics programs.

ACJ Informatics and Training is a young computer and information systems supplying and training company, located in Faro, the Algarve region capital. Was established in 2013 to fill the gap in IT supplying and service in the region. It's located next to the University of the Algarve (Gambelas Campus), one of its main clients. ACJ offers professional training, especially in the fields of Information Technology and international teacher training. It's collaborators and trainers are experts on computer sciences and are certified teacher trainers. Trainers have extensive experience in educational technology training at national and international levels and in participation and coordination of Erasmus European projects.

Khan Academy: created in 2006 by American Salman Khan, the Khan Academy website, now adapted to the Portuguese curricula, and made available by the PT

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 PT 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.

8.2.3. Technologies used

Mobile technologies are an attractive and easy means to maintain literacy skills and gain constant access to information. They are affordable, can be easily distributed and thus hold great potential for reaching marginalized groups and providing them with access to further learning and development. Mobile technologies facilitate distance learning in situations where access to education is difficult or interrupted because of geographical location or due to post-conflict or post-disaster situations.

GooseChase can be used to organize educational scavenger hunts for your face-to-face and even online courses. Students can check-in to locations using GPS, capture and create photos and videos, and draft and submit text in response to your queries.

FluentU is a popular platform for language learning that uses real world videos. They take videos from Youtube and add interactive captions.

Their method allows you to learn words in context in a natural way.

OneNote can capture and sync your notes to the cloud or across devices using text, handwriting, images, or audio clips. Shared notebooks allow users to view or co-edit documents.

EduMe is a Workforce Success platform used by modern companies across 6 continents to train, engage and communicate with their workforce. By having effective learning and relevant information in the palm of their hands, the workforce at companies like Uber, Airbnb, Vodafone and Deloitte are empowered to perform at their best.

Poll Everywhere, allows you to create real-time polls with either open-ended or quantitative questions. Students can respond through its app, the mobile web, a laptop, or text messages, and you can see responses from all your students in real-time. DePaul has a limited license for the premium version of Poll Everywhere. If you are interested in using Poll Everywhere, we recommend you set up a free account, try it out, and if you are interested in advanced features like unlimited responses per poll or graded questions, fill out this form to request premium access.

QuizUp is a mobile game originally developed and published by Iceland-based Plain Vanilla Games, and now operated by Glu Mobile. The game is a mobile trivia app like the game Trivial Pursuit. QuizUp is a multiplayer game in which one user competes against another during seven rounds of timed multiple-choice questions of various topics.There are over 1,200 total topics available to users to choose from, and all the questions are voluntarily submitted by content contributors. Most topics are available in different languages.

Kahoot is a free team-based speed game in which students answer multiple-choice questions together on their own web-enabled devices. Because it is team-based and competitive, it is a great way to add engagement to your class.

Quizlet is a tool that allows students the ability to create digital flashcards. It also supports other study prep tools, such as fill-in-the-blank quizzes, spelling tests, and even games like matching. Requires a Google login but is free to use.

Tinycards is another free flashcard tool made by the team that created the Duolingo language-learning app. It has a native app for iOS and Android. Tinycards has pre-built "decks" for language learning and allows you or students to create custom decks.

8.2.4. Learning topics and places

Mobile learning is not just online learning on a smaller screen. Smartphones have some limitations compared to computers but also unique affordances that can allow for new kinds of learning experiences. These affordances have been identified as the five "C's" of Mobile Learning by Clark Quinn:

- Content: Providing instructional materials that students can access anywhere, or in specific contexts (like instructor commentary for a museum trip).
- Capture: Using mobile devices to capture images, video, sound, GPS coordinates, and ideas (as notes).
- Communicate: Being able to stay in touch with classmates anywhere or during specific field activities.
- Compute: Using devices to assist in calculating, language translating, and other computational tasks.
- Combine: Using the previous four functions together in interesting ways, like augmented-reality experiences that capture GPS location, orientation, and images, and supply relevant content to the learner.

Mobile learning is emerging as one of the solutions to the challenges faced by education. With a variety of tools and resources always available, mobile learning provides increased options for the personalization of learning. Mobile learning in classrooms often has students working interdependently, in groups, or individually to solve

problems, to work on projects, to meet individual needs, and to allow for student voice and choice. With access to so much content anytime and anywhere, there are plenty of opportunities for formal and informal learning, both inside and outside the classroom.

Study showed that notebooks, mobile Tablets, iPod touch, and iPads are very popular devices for mobile learning because of their cost and availability of apps. They are used for collecting students' responses (clickers), reading electronic books and websites, recording reflections, documenting field trips, collecting and analyzing data, and much more. The future of mobile learning depends largely on the level of social acceptance it receives. On the other hand, Users in developing countries have the same need for M-Learning to be mobile, accessible and affordable, as those in developed countries do. The very significance of M-Learning is its ability to make learning mobile, away from the classroom or workplace.

All students enrolled in higher and further education institutions today have frequent needs for information from their institutions about timetable changes, assessment deadlines, feedback from tutors and other urgent administrative details. The use of mobile telephony is a much more efficient and quicker means of communication that postal contact or email. Once this has been achieved the use of mobile learning for academic contact in colleges and universities can be added.

8.2.5. Communication channels

Facebook Messenger: Is a FREE mobile messaging app used for instant messaging, sharing photos, videos, audio recordings and for group chats. The app, which is free to download, can be used to communicate with your friends on Facebook and with your phone contacts.

The Messenger app is a separate app to Facebook. However, users' profiles can be set using their Facebook account or telephone number.

Slack is a meeting space, water-cooler, bulletin board, and phone-tree for your whole organizing team. It's a great place to coordinate and collaborate, and a fun place to get to know your fellow organizers and activists, even when you can't all be in the same room at the same time. It's a tool that you can use on your computer and your phone to stay in touch with your team and keep everyone up to date with the important news and goings-on.

Slack can replace email, text messaging, and instant messaging for your team, and keep all those communication styles together in one app. With both desktop and mobile versions, Slack can help your team collaborate and coordinate their work no matter where they are — in the field office, at home, or out knocking doors.

Microsoft Teams offers several different ways to communicate with learners:

- Conversations (Teams — Semi-synchronous)
- Files (OneDrive — Asynchronous)
- Content (OneNote — Asynchronous)

- Outcomes (Planner — Asynchronous)

Conversations, files, content, and outcomes in aggregate offer forms of communication that may be synchronous, semi-synchronous, and asynchronous as well as emerging in and outside of the classroom. The reasoning for using Microsoft Teams (Teams, OneDrive, OneNote, and Planner) is to have options in the types and modes of communication so that as the course transpires, adaptations to assessment and instruction can be made as needed.

Google Drive is a file storage and synchronization service developed by Google. Launched on April 24, 2012, Google Drive allows users to store files on their servers, synchronize files across devices, and share files. In addition to a website, Google Drive offers apps with offline capabilities for Windows and macOS computers, and Android and iOS smartphones and tablets. Google Drive encompasses Google Docs, Google Sheets, and Google Slides, which are a part of an office suite that permits collaborative editing of documents, spreadsheets, presentations, drawings, forms, and more. Files created and edited through the office suite are saved in Google Drive.

Whats up: since launching in 2009, WhatsApp has become the world's most popular text and voice messaging application. Specializing in cross-platform messaging, WhatsApp is a free service that lets users message one another seamlessly between mobile and desktop devices.

WhatsApp is known for its enhanced privacy features, such as end-to-end encryption, and its free, web-based international calling. Read on to find out how you can leverage the Facebook-owned messaging giant to make free international calls.

8.2.6. Usability condition

Due to its characteristics, M-learning in formal education is useful as a complementary form of education in traditional and online education. Above all, it is important to take advantage of its advantages when learning opportunities outside the usual locations are to be provided and where authentic or situational learning is at the forefront of learning strategies.

Mobile learning is not just online learning on a smaller screen. Smartphones have some limitations compared to computers but also unique affordances that can allow for new kinds of learning experiences. These affordances mostly belong to:

- Content: Providing instructional materials that students can access anywhere, or in specific contexts (like instructor commentary for a museum trip).
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- Communicate: Being able to stay in touch with classmates anywhere or during specific field activities.
- Compute: Using devices to assist in calculating, language translating, and other computational tasks.

- Combine: Using the previous four functions together in interesting ways, like augmented-reality experiences that capture GPS location, orientation, and images, and supply relevant content to the learner.

8.2.7. 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

The definition of virtual reality comes, naturally, from the definitions for both 'virtual' and 'reality'. The definition of 'virtual' is near and reality is what we experience as human beings. So the term 'virtual reality' basically means 'near-reality'. This could, of course, mean anything but it usually refers to a specific type of reality emulation.

Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.

We know the world through our senses and perception systems. In school we all learned that we have five senses: taste, touch, smell, sight and hearing. These are however only our most obvious sense organs. The truth is that humans have many more senses than this, such as a sense of balance for example. These other sensory inputs, plus some special processing of sensory information by our brains ensures that we have a rich flow of information from the environment to our minds.

Everything that we know about our reality comes by way of our senses. In other words, our entire experience of reality is simply a combination of sensory information and our brains sense-making mechanisms for that information. It stands to reason then, that if you can present your senses with made-up information, your perception of reality would also change in response to it. You would be presented with a version of reality that isn't there, but from your perspective it would be perceived as real. Something we would refer to as a virtual reality.

So, in summary, virtual reality entails presenting our senses with a computer-generated virtual environment that we can explore in some fashion.

In technical terms…

Answering "what is virtual reality" in technical terms is straight-forward. Virtual reality is the term used to describe a three-dimensional, computer generated environment which can be explored and interacted with by a person. That person becomes part of this virtual world or is immersed within this environment and whilst there, is able to manipulate objects or perform a series of actions.

In Virtual Reality (VR), the users' perception of reality is completely based on virtual information. In Augmented Reality (AR) the user is provided with additional computer-generated information that enhances their perception of reality.

In Virtual Reality (VR), the users' perception of reality is completely based on virtual information. In Augmented Reality (AR) the user is provided with additional

computer generated information that enhances their perception of reality.[18][19] For example, in architecture, VR can be used to create a walk-through simulation of the inside of a new building; and AR can be used to show a building's structures and systems super-imposed on a real-life view. Another example is through the use of utility applications. Some AR applications, such as Augment, enable users to apply digital objects into real environments, allowing businesses to use augmented reality devices as a way to preview their products in the real world. Similarly, it can also be used to demo what products may look like in an environment for customers, as demonstrated by companies such as Mountain Equipment Co-op or Lowe's who use augmented reality to allow customers to preview what their products might look like at home through the use of 3D models.

Augmented Reality (AR) differs from Virtual Reality (VR) in the sense that in AR part of the surrounding environment is actually 'real' and just adding layers of virtual objects to the real environment. On the other hand, in VR the surrounding environment is completely virtual. A demonstration of how AR layers objects onto the real world can be seen with augmented reality games. WallaMe is an augmented reality game application that allows users to hide messages in real environments, utilizing geolocation technology in order to enable users to hide messages wherever they may wish in the world. Such applications have many uses in the world, including in activism and artistic expression.

8.3.1. Activities/phases of teaching model

Education can benefit from technologies and tools that can provide experiences that, otherwise, would not be possible. Some applications are based on Virtual Reality and require specific hardware, such as HTC Vive, Google Cardboard or others, and others resort to Augmented Reality through smartphones.

Successful education engages students in learning, collaborating and creating. It fosters rich discussion, help students visualize abstract concepts, encourages them to identify challenges and supports them in creating solutions. Virtual reality is changing how students are learning, collaborating, and creating by providing experiences that teach through exploration. Immersive technology is the next step in the natural evolution of computer-based instruction and can deliver experiences that are not otherwise possible with traditional books or videos. This technology allows students to learn about topics by living in them and interacting with them, which makes learning more memorable. In VR, dynamic experiences lead students to discover for themselves, which encourages them to learn through curiosity and exploration. Virtual reality also presents an opportunity for collaboration between peers. Teachers that have used virtual collaboration with their students report that at this virtual level, students are more likely to interact with each other. The technology is also being used to create personalized learning environments for students with special needs. Special education

teachers are using VR to calm and refocus students experiencing sensory overload. With 3D modelling and VR creation, students have a powerful new tool to express their understanding, create solutions, tell stories or create artwork. Virtual Reality (VR) and Augmented Reality (AR) are both trending topics not just in the consumer market, but in education as well. How does this look in Education? Is it realistic to run a classroom where 30 students are wearing VR headsets? The answer is yes, and there are many classrooms around the Globe which are already embracing this new technology.

The use of VR in education assists students in understanding complex ideas more clearly, as well as new theories and concepts. Using VR, digesting and retaining complex information is easier, more efficient and funnier. A positive learning environment means a solid basis leading to better achievements in learning. Virtual reality in education and training is the perfect tool for students who strive to obtain as much knowledge from their classes as possible and apply it in the future. Students are easily distracted. According to research, students spend 20% of their classroom time absorbed in their mobile devices that has nothing to do with their studies. This means smartphones distract students' attention from studies. VR technologies contribute to a better learning environment because students no longer waste time staring at their smartphones. Instead, using VR technologies, they are fully engaged and focused as essential during a learning process, using their habitual gadgets. Using VR devices, students better understand educational visualizations. With VR, students are able to experience and explore a myriad of realities and gain applicable learning experiences. This greatly enhances the entire learning process. Another important benefit of using VR in education and training is great student participation. When students are fully engaged in the learning process, we witness tremendous beneficial results. In modern multicultural societies, language differences can be a challenge. Students with an eye on studying abroad need to have in-depth knowledge of a foreign language to fully understand the material. Virtual reality enables built-in translations. Most obstacles between students and their educational goals disappear. With 3D modelling and VR creation, students have a powerful new tool to express their understanding, create solutions, tell stories or create artwork. Powering what is possible in Education, is how cutting-edge technology transforms lessons into immersive experiences, defies distance and pushes boundaries.

Advanced Learning Analytics in Online Training

Virtual & Augmented Reality has been around in one form or another for many years. The term virtual reality is used to describe an immersive experience through a computer in an environment which doesn't exist. Virtual means near while reality is what we experience, so the term virtual reality roughly translates to near reality.

Education is perhaps one of the main areas where virtual & Augmented reality can make the most difference. Although it is primarily assigned to games, virtual reality can have a significant impact in learning and development.

It enables the student to enter a 360-degree video shot or immerse themselves in a 3D environment. Marine biologists for example can enter the natural environment of the ocean all without stepping foot near a boat or the coast. The lecturer will activate a series of scenarios and wearing virtual reality glasses, the students can experience the actual environment. Virtual learning environments are also created in online education where students can send, create and manage coursework and study digital material.

In recent years, virtual reality has been slowly entering the world of training and elearning. We could define 5 Practical Ways of Using AR and VR in eLearning:

- Enhanced online training simulations
- Immersive gamification in eLearning courses
- Customized learning paths in web-based courses
- eLearning assessments with visual feedback
- Advanced learning analytics in online training

The use of virtual learning in the delivery of training would require businesses to purchase virtual reality headsets and Smartphone's. Responsive content is created so that students can use specially designed technologies to create unique 3D learning experiences.

8.3.2. Educational resources

There are plenty of different tutorial videos on Youtube and articles on internet regarding applying the methods of AR and VR in different learning pathways. We give some examples of educational ressources:

Human body simulator: this application represents, in Virtual Reality, a human body. It allows exploring internal organs and systems in a totally immersive 3D environment, customize physiology and simulate diseases in different levels of severity.

Arflashcards: this application can be used in a smartphone to browse physical cards placed on a table. When the smartphone detects a specific card, it overlays an augmented reality content, associated with the card's design.

HP Reveal: instead of browsing third party content, this HP Reveal allows creating content and associate it with physical objects, such as a book or a landscape. Later, the 3D model will be visualized in augmented reality within the app.

Interactive sandbox is a setting, composed of a sandbox, a kinect sensor, a computer and a video projector to support mixing physical with virtual content. This provides a rich visualization and manipulation environment for students.

ClassVR: is a versatile platform using the power of Virtual and Augmented Reality for education and training from the classroom to the boardroom.

Daydream: a platform for high quality, mobile VR made to take you on incredible adventures.

Expeditions: take students on virtual field trips with educational tools.

8.3.3. Technologies used

VR Game Engine and WebVR: this software provides developers with the essential for creating a VR video game experience and Web VR experiences.

VR SDK: virtual reality software development kits (SDK) provide the necessary base to design, build, and test VR experiences. VR SDKs are the foundation to creating practically any VR experience, the building blocks.

VR App Software Development: this type of software allows users to create VR apps and experiences with easy-to-use Interface, aggregating data in a virtual environment. These tools enable users to see analytics in a way for them to fully understand what the data are communicating.

Unreal Engine (UE4): one of Unity 3D's primary competitors, is also an asset store, great documentation, and a gaming engine with VR integrations. Created by Epic Games, Unreal is the engine behind plenty of fantastic, high action games that offer an unprecedented level of details and graphics.

WebVR Browser API provides purpose-built interfaces to VR hardware to allow developers to build compelling, comfortable VR experiences at a web browser. The WebVR browser API makes it possible for web pages that can use JavaScript to access a VR headset's headset & controller orientation & position data, then uses that data to create the suitable stereoscopic views into the VR headset with WebGL.

Wearable devices include headsets, VR glasses and, in the future, contact lenses. Static devices include mobile devices (smartphones, tablets, etc.), landline devices (TVs, PCs) and head-up displays.

HTC VIVE SDKs HTC: this app offers a whole network for developers seeking to create VR content around its Vive brand products. The company recently released the HTC Vive Pro (shown above), with a heavy emphasis on attracting enterprise VR users and developers.

Creator AVR (EON Reality, Inc): this virtual reality (VR) and augmented reality (AR) software developer from EON Reality Inc., is a mobile-based application called EON Creator AVR (Augmented Virtual Reality). The company specializes in VR-based knowledge transfer for industry, education, and entertainment, with the new app aimed at teachers and students.

Anatomy 4D is an excellent example of such AR development. When printed targets are scanned, students see a 3D model of the human body that can be interacted with.

Quiver – 3D Coloring App: in addition to the items listed above, this AR app will also require students to break out their coloring pencils.

To use Quiver, educators will need to print out coloring pages (trigger images provided by QuiverVision) which students color in.

Arloon Plants, Arloon Mental Math, and Arloon Geometry focus on botany, arithmetic, and geometry.

Aurasma and Blippar both provide tools to facilitate the creation of AR experiences.

8.3.4. Learning topics and places

This may seem like a lot of effort, and it is! What makes the development of virtual reality worthwhile? The potential entertainment value is clear. Immersive films and video games are good examples. The entertainment industry is after all a multi-billion dollar one and consumers are always keen on novelty. Virtual reality has many other, more serious, applications as well.

There are a wide variety of applications for virtual reality which include: Architecture, Sport, Medicine, Arts, Entertainment and others.

Virtual reality can lead to new and exciting discoveries in these areas which impact upon our day to day lives.

Wherever it is too dangerous, expensive or impractical to do something, virtual reality is the answer. From trainee fighter pilots to medical applications trainee surgeons, virtual reality allows us to take virtual risks in order to gain real world experience. As the cost of virtual reality goes down and it becomes more mainstream you can expect more serious uses, such as education or productivity applications, to come to the fore. Virtual reality and its cousin augmented reality could substantively change the way we interface with our digital technologies. Continuing the trend of humanising our technology.

We have many different types of virtual reality systems, but they all share the same characteristics such as the ability to allow the person to view three-dimensional images. These images appear life-sized to the person.

Plus, they change as the person moves around their environment which corresponds with the change in their field of vision. The aim is for a seamless join between the person's head and eye movements and the appropriate response, e.g. change in perception. This ensures that the virtual environment is both realistic and enjoyable.

A virtual environment should provide the appropriate responses – in real time- as the person explores their surroundings. The problems arise when there is a delay between the person's actions and system response or latency which then disrupts their experience. The person becomes aware that they are in an artificial environment and

adjusts their behaviour accordingly which results in a stilted, mechanical form of interaction.

8.3.5. Communication channels

Google Cardboard's "Expeditions": program lets teachers take students on immersive, virtual journeys to, say, coral reefs – or to the surface of Mars.

ARCore – Google's AR developer platform provides simple yet powerful tools to developers for creating AR experiences. ARCore's features include:

- Cloud Anchors
- Multi-user, cross-platform experiences across both Android and iOS.
- Augmented Faces
- Facial tracking with: a 468 point 3D face mesh on devices without a depth sensor.
- Environmental HDR
- Lighting extension from the real world onto virtual objects to make digital objects appear like they're actually part of a real-world scene

8.3.6. Usability condition

Some of the common challenges of using augmented reality technology is that there's a struggle to use the new technologies by teachers. Moreover, not all students have the smartphones capable of supporting AR content. Virtual Reality, on the other hand, faces completely different challenges. High costs of hardware, accessibility and lack of quality content are some of the constraints that have kept VR from being the breakthrough technology in education.

But on the other hand, like in traditional home-based education, e-learning can take advantage of the benefits of AR and VR for more authentic and active learning.

The greatest benefit of the immersivness of the virtual environment is the accurate simulation of real situations. The associated use of VR can be useful in public speaking training, physician training, and the like.

Considering that education is usually a government-funded affair, the cost-effectiveness of implementing AR/VR technologies is the question that arises most often. (Granted, we're not just talking about school education, but also professional training - for example, for surgeons.)

While a virtual reality education platform can be a great help in the learning process, here are the things that you should take into account when calculating the costs:

You will need to invest into gear to make the VR solution available (helmet or glasses + controllers). Thankfully, there are budget options available that are quite good

(for example, Google Cardboard). A business analyst can help you figure out what things the gear should be able to do and then it's up to you and your investors.

You will need to invest in the actual AR/VR content development. While there are solutions that come with building blocks (that you can assemble in whatever way you need), some special training might require starting the development from scratch.

You will need to invest time (and possibly money) into training your teachers how to operate the gear properly so that they are fully prepared to teach the students.

Compared to Virtual Reality, AR solutions are cheaper because you don't need specific gear. All your student needs is a smartphone. However, you still need to develop the content for the app.

In the long run, if implemented properly, VR/AR solutions can pay off greatly in a form of highly trained professionals ready for action and other benefits of AR / VR in education are obvious. It can have an incredible impact both for the system itself and for the technology as both of them adapt to the new status quo and develop new models of operations.

One of the biggest roadblocks for wide implementation of VR and AR solutions in the educational process is purely practical - it takes a lot of effort (both on developers and educators' sides) to create quality AR/VR content that will cover the needs of the educational programs.

8.3.7. 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

Flipped Learning is a framework that enables teachers to reach every student in every classroom every day. The flipped approach inverts the traditional classroom model by introducing the course material before class, allowing teachers to use class time to guide each student through active, practical, innovative applications of the course content.

Flipped Learning is transformative because shifting the basic instruction outside of the classroom gives teachers the class time to use all forms of active learning strategies. As such, Flipped Learning is a framework that enables and supports all of the most effective instructional models of the day.

9.1.1. Activities/phases of teaching model

The class activities will vary depending on the classroom setting, the subject and the context. Students should be given a choice or variety of activities to perfect and demonstrate their understanding of a topic, supported by the teacher and their peers. They may include debate or speech presentation, research or design assignments, discussions, questions and answers, problem solving activities, projects or group work. Students could produce their own videos or written exams could be replaced by videos.

The cycle often begins with an experiential exercise. 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, theatre, museum ... or the creative teacher could provide some type of hands-on activity or simulation for Students to complete during a real-time synchronous webinar session via Microsoft Teams, Webex, Zoom, Teamviewer...

Concepts should be presented in accessible form. By providing students with online resources and downloadable media, students can control when and how the media is used. These materials are used by the students 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 Student to differentiate learning for him/herself.

Students 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. Students 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. If possible, students 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.

At the end students 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 Students have to create something that is individualized and extends beyond the lesson with applicability to the students' everyday lives. In essence, they become the storytellers of their learning. This phase 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 teacher can guide the student 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.

9.1.2. Educational resources

Academic and Research Network of Slovenia (Arnes) has been founded by the Government of Slovenia in 1992. Since then it has significantly contributed to the informatization of Slovenian society, including the whole school system. Today, Arnes provides network services to more than 1,500 universities, institutes, research laboratories, museums, schools, databases and digital libraries with a reliable and efficient infrastructure. It has more than 250,000 users and offers them the same services as national academic networks in other countries; it cooperates with these networks in European Commission projects to test, develop and introduce new Internet protocols and services. It also provides services that are not offered by commercial organizations but which are essential to the operation of the Internet in Slovenia.

Arnes will also continue to supply users with e-services and e-contents and to develop new ones (e.g., e-classroom-also in App version, MOOCs).

SIO – Slovenian Educational Network: the purpose of the SIO website is to connect and integrate projects, activities and services of the Slovenian education system.

As a connecting point of information for various e-communities, it will provide:

- access to a catalog of trainings - seminars, workshops, online courses
- uniform information service in the field of calls and conferences
- uniform venue for seminars and workshopsdevelopment
- and access to a repository of various resources
- ….

The SIO 2020 is co-financed by European Regional Development Fund and Ministry of Education.

9.1.3. Technologies used

Google Classroom: Teachers use Google Classroom in a variety of ways – to deliver assignments to students and to provide effective and efficient feedback, for example – and it can be a great landing page for students as they navigate assignments. At the beginning of a lesson, teachers can direct students to assignment goals, objectives, and instructions in Classroom. Classroom can also be used to distribute a lesson's digital texts and other resources.

In flipped environments where students take notes on instructional videos digitally, classroom can be used to assign a unit Google Doc to students for that purpose. Teachers can establish this procedure as a norm at the beginning of the school year so students know that they should begin each class period by going to Google Classroom.

Edpuzzle: Instructional videos are an important component of the flipped classroom. While there are many schools of thought concerning teacher presence and action in these videos and how long they should be, most teachers would agree that

students should be held accountable for the video content and that teachers should have a way to monitor student progress and provide timely feedback.

Edpuzzle allows teachers to do just that, and it provides teachers with the ability to embed a variety of formative assessments into videos they create or use from other sources. Students can access Edpuzzle videos from any browser or through iOS or Android apps, so it's very convenient.

Padlet: After students have viewed an instructional video, it's a good idea to provide them with an opportunity to reflect on the content. Padlet provides teachers with a way to have students not only review and reflect on content, but also collaborate with their peers.

Teachers can create a new Padlet wall for each video or unit and encourage students to ask questions and answer their peers' questions about content as a review for unit assessments. Using an extension such as Screencastify, teachers can create screencasts of the Padlet wall for their students to use as a study aid.

Quizizz: Formative assessment is extremely important in any classroom, and flipped classrooms are no exception. The flipped strategy puts more responsibility for viewing and interacting with content on the students, and formative assessment is therefore needed after every video.

Teachers can create gamified formative assessment activities for their students using Quizizz and assign these activities as homework, which allows the students to play the games individually. Quizizz activities can also be used as a whole-class formative assessment – students enjoy Quizizz because of the gamified component of the activity and the memes that greet them when they respond to each question.

With the help of these tools, teachers can implement a flipped classroom approach – with students working on their own either at home or in the classroom – and provide a more individualized learning experience for all of their students.

9.1.4. Learning topics and places

The benefits include allowing students to work at their own pace, to determine for themselves the material they need to review, and to apply concepts in different contexts in class to ensure that they thoroughly understand of the content.

But this model can be unsuccessful if students don't do the advance work – if they don't have access to reliable internet outside of school, for example. Students who are unable to complete the advance work the evening before find themselves either unable or ill-prepared to participate in class activities the following day.

One solution is to keep the advance work in the classroom – students can reap the benefits of flipped instruction while doing everything in class. In this model, teachers give their students time to watch the video or read a text in class; students then do the follow-up work, with the teacher providing help and guidance as needed. This is

extremely helpful for students who need help with the content they're learning in the video.

The teacher still moves from being the "sage on the stage" to the "guide on the side" by providing individualized help for each student. While some teachers may prefer to avoid whole-class direct instruction, others may find it helpful for their students when reviewing content or demonstrating or revisiting a concept. Part of the beauty of the in-class flipped model is that it provides a great deal of flexibility for teachers based on their students' needs.

Current evidence suggests that the flipped classroom approach in health professions education yields a significant improvement in student learning compared with traditional teaching methods, quite often is also used when teaching natural science, maths...

9.1.5. Communication channels

Slack is a meeting space, water-cooler, bulletin board, and phone-tree for your whole organizing team. It's a great place to coordinate and collaborate, and a fun place to get to know your fellow organizers and activists, even when you can't all be in the same room at the same time. It's a tool that you can use on your computer and your phone to stay in touch with your team, and keep everyone up to date with the important news and goings-on.

Slack can replace email, text messaging, and instant messaging for your team, and keep all those communication styles together in one app. With both desktop and mobile versions, Slack can help your team collaborate and coordinate their work no matter where they are — in the field office, at home, or out knocking doors.

Microsoft Teams offers several different ways to communicate with learners:

- Conversations (Teams – Semi-synchronous)
- Files (OneDrive – Asynchronous)
- Content (OneNote – Asynchronous)
- Outcomes (Planner – Asynchronous)

Conversations, files, content, and outcomes in aggregate offer forms of communication that may be synchronous, semi-synchronous, and asynchronous as well as emerging in and outside of the classroom. The reasoning for using Microsoft Teams (Teams, OneDrive, OneNote, and Planner) is to have options in the types and modes of communication so that as the course transpires, adaptations to assessment and instruction can be made as needed.

Google Drive is a file storage and synchronization service developed by Google. Launched on April 24, 2012, Google Drive allows users to store files on their servers, synchronize files across devices, and share files. In addition to a website, Google Drive offers apps with offline capabilities for Windows and macOS computers, and Android and iOS smartphones and tablets. Google Drive encompasses Google Docs, Google

Sheets, and Google Slides, which are a part of an office suite that permits collaborative editing of documents, spreadsheets, presentations, drawings, forms, and more. Files created and edited through the office suite are saved in Google Drive.

Whats up: since launching in 2009, WhatsApp has become the world's most popular text and voice messaging application. Specializing in cross-platform messaging, WhatsApp is a free service that lets users message one another seamlessly between mobile and desktop devices.

WhatsApp is known for its enhanced privacy features, such as end-to-end encryption, and its free, web-based international calling. Read on to find out how you can leverage the Facebook-owned messaging giant to make free international calls.

9.1.6. Usability condition

When you eliminate traditional lecture, you also lose the static rows of seating in favor of flexible arrangements. Furniture should be modular and allow for a variety of group and individual work. Likewise, the timing of lessons needs to be flexible to allow for students to fully explore a topic and understand it at their own pace.

Instead of traditional teacher-centric learning, the flipped classroom puts students at the center of the lesson. Students guide the pace and style of learning, and instructors play the role of the "guide on the side". Instructors will help students through an experiment or guide them through a practice set when they need assistance applying new information.

Instructors who embraced the flipped learning model are always on the lookout for ways to maximize their classroom time so that students are actively engaged in learning and hands-on practice. This approach requires prioritizing lessons that work in such a model and figuring out ways to encourage learners to work independently.

The flipped model requires instructors to constantly monitor their students in order to identify who needs help with what and why. Instructors need to be responsive and flexible, and they must understand that this highly active style of teaching takes great pedagogical skill. Despite being less visible, instructors need to be at the top of their game to nurture students in a flipped classroom.

Schools should consider when researching or implementing the flipped classroom:

- How to make videos easily available, consistently and securely?
- How to enable teachers to record video in any location?
- Ensuring instructors can record anything, no matter how complex?
- Ensuring students can watch videos anytime, anywhere, on any device?
- Ensuring students can find any topic in any video when needed?

9.1.7. 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

The development of e-learning has been marked by mobile learning or M-learning over the last decade. With the rise of mobile telephony, and above all with the rapid expansion of smartphones, education has gained new opportunities in choosing the time, location and way of learning. Increasingly powerful tools, tools and applications make m-learning not just another form of first generation e-learning, characterized by access to learning content and co-munitions using mobile devices. Functionalities such as high-performance camcorders, sound recorders, GPS systems, Internet of Things (IOT) and use of your own devices (BYOD) are opening new dimensions to technology-enabled education, whether from exercises in the classroom, combined or online, during apprenticeship process or intended for non-formal education such as on-the-job training. The breakthrough of M-learning is not only the result of the extremely rapid technological development of mobile devices, but also of the high level of their prevalence. According to Eurostat (Eurostat, 2019), in 2018 in the EU-28, three quarters of the adult population had smartphones, with only slightly fewer (71%) in Slovenia. Smartphones have become an inseparable tool of our day-to-day work and personal lives and the natural step is to enter the field of education.

9.2.1. Activities/phases of teaching model

In M-learning learning activities are designed to adapt to specific circumstances. For example, students get to know an artist by discussing them by sharing pictures they took while visiting the gallery, or by sharing resources about that artist that they searched for online, depending on the circumstances.

M-learning takes place in special circumstances, so it is only necessary to directly enter into m-learning programs, which is strictly necessary to achieve the learning objectives. Additional information can be provided in a badge with relevance (for example, as a recommended reading).

In m-learning, participants expect an immediate response and are also quite patient in content delivery. Unless absolutely necessary, we avoid graphical displays and try to present the content as concisely as possible. Content is presented in a structured way (for example, with simple schemas), which increases transparency and reduces file size.

M-learning needs to be tailored to the nature of the mobile device and how it is used. Users do not have a mobile phone in their hands all the time or for a long time, just as they can sit behind a computer for hours. They usually use the phone in different activities, often in adverse circumstances, disturbances, noise, etc. Teaching units in m-learning are relatively small chunk content and are often derived from the principles of micro-learning. Ideally, these units should last anywhere from 5 to 10 minutes, but in no case longer than 15 minutes.

With m-learning, quality navigation and the proper structure of the website are of great importance. The user expects the most important information, once he / she enters the program, followed by clear instructions and a logically designed learning path. Before putting a ready-made m-learning unit into service, it is essential to test and pilot it. Most users use multiple electronic devices per day. The m-learning format must be automatically adjusted to the screen size so that the user sees the content equally well regardless of the device used.

The main one is simplicity. Too many options and elements can confuse the students. Each button, image and paragraph makes the screen less transparent and more demanding to use. It should also be borne in mind that users perform most of the operations with one or at most two fingers. It should be noted that complex images on smaller screens are not appropriate as details are lost. It is better to send such information in the attachment.

Mobile devices work with the touch of a screen, which is much different than clicking and using a mouse. Therefore, it is advisable to design simple menus, enlarge buttons and touch sensitive areas.

9.2.2. Educational resources

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The SIO 2020 is co-financed by European Regional Development Fund and Ministry of Education.

9.2.3. Technologies used

Apps such as **GooseChase** can be used to organize educational scavenger hunts for your face-to-face and even online courses. Students can check-in to locations using GPS, capture and create photos and videos, and draft and submit text in response to your queries.

Apps such as **OneNote** can capture and sync your notes to the cloud or across devices using text, handwriting, images, or audio clips. Shared notebooks allow users to view or co-edit documents.

Poll Everywhere allows you to create real-time polls with either open-ended or quantitative questions. Students can respond through its app, the mobile web, a laptop, or text messages, and you can see responses from all your students in real-time.

Kahoot is a free team-based speed game in which students answer multiple-choice questions together on their own web-enabled devices. Because it is team-based and competitive, it is a great way to add engagement to your class.

Quizlet is a tool that allows students the ability to create digital flashcards. It also supports other study prep tools, such as fill-in-the-blank quizzes, spelling tests, and even games like matching. Requires a Google login but is free to use.

Tinycards is another free flashcard tool made by the team that created the Duolingo language-learning app. It has a native app for iOS and Android. Tinycards has pre-built “decks” for language learning, and allows you or students to create custom decks.

9.2.4. Learning topics and places

M-learning is much more suitable for non-formal education, especially for providing just-in-time and just-in-place training. These types of training are usually limited to short, content-focused content sets that can also be learned through microlearning.

9.2.5. Communication channels

Slack is a meeting space, water-cooler, bulletin board, and phone-tree for your whole organizing team. It's a great place to coordinate and collaborate, and a fun place to get to know your fellow organizers and activists, even when you can't all be in the same room at the same time. It's a tool that you can use on your computer and your phone to stay in touch with your team and keep everyone up to date with the important news and goings-on.

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9.2.6. Usability condition

Due to its characteristics, M-learning in formal education is useful as a complementary form of education in traditional and online education. Above all, it is important to take advantage of its advantages when learning opportunities outside the usual locations are to be provided and where authentic or situational learning is at the forefront of learning strategies.

Mobile learning is not just online learning on a smaller screen. Smartphones have some limitations compared to computers but also unique affordances that can allow for new kinds of learning experiences. These affordances mostly belongs to:

- Content: Providing instructional materials that students can access anywhere, or in specific contexts (like instructor commentary for a museum trip).
- Capture: Using mobile devices to capture images, video, sound, GPS coordinates, and ideas (as notes).
- Communicate: Being able to stay in touch with classmates anywhere or during specific field activities.
- Compute: Using devices to assist in calculating, language translating, and other computational tasks.
- Combine: Using the previous four functions together in interesting ways, like augmented-reality experiences that capture GPS location, orientation, and images, and supply relevant content to the learner.

9.2.7. 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

We're living in a digital age where technology has had a transformative effect on the way we live and work. Slowly and steadily, technology has been making strides in revolutionizing methods of learning and teaching. Technology-enabled curriculum and smart boards have long replaced traditional blackboards and two-dimensional textbook images. As we move into the next generation of media transformation, AR (Augmented Reality) and VR (Virtual Reality) are becoming the hottest topics in education technology.

When we first hear the words AR and VR, the first thought that comes to mind is games. This is because AR and VR technology has been extensively used in the gaming arena. Remember the popularity of the AR game "Pokemon GO" which became a worldwide sensation with over 100 million users at its peak in 2016. The game used Augmented Reality, also known as AR. Augmented Reality is the result of using technology to superimpose digital elements — sounds, images, and text to the world we see using a tablet, smart eyeglass or a smartphone camera. Virtual reality is significantly more complex with an immersive, three-dimensional, computer-generated environment which can be explored and interacted with by a person. Instead of projecting the images and sounds on a real environment, virtual reality uses a VR headset to immerse users on the 360-degree environment they want to be in.

9.3.1. Activities/phases of teaching model

By creating an immersive and interactive learning experience without the use of textbooks, AR and VR technology empowers learners to explore and learn at their own pace, thus stimulating learning and comprehension and enhances critical retention. VR and AR-based apps for education, that combine digital technologies and learning, improve the educational process and allow students to acquire information visually. These technologies provide a solid base to improve the education process. For example, a learner can learn about jungle animals by taking an expedition through a digital jungle using a smartphone app, simple cardboard VR glasses and earphones. Without having to step out of the classroom or their home, students are exposed to completely new and active learning environments.

Application in process of learning:

1. **Enhanced Online Training Simulations**

The present simulations in online learning involve the use of either desktops/laptops or mobile devices, which leave ample scope for distractions. However, the principle behind AR and VR is to completely immerse learners in a virtual situation. Audio devices and headsets allow plugging out any external distractions and concentrating on the virtual learning activity.

For instance, use AR and VR for online compliance safety training simulations. Enable learners to step into a virtual learning environment and interact with virtual elements in real-life setups to prevent workplace accidents and injuries. You can simulate a compliance safety scenario and analyze how your learners fare in it.

2. Immersive Gamification in eLearning Courses

Gamified eLearning courses have been one of the effective ways to make learning engaging and fun. However, with AR and VR, you can provide an immersive learning experience to shape the future of gamification in the eLearning landscape.

For instance, one of the disadvantages of modern gamification is the use of virtual rewards. With AR and VR technologies, your learners can earn tangible badges and rewards as well as physically move up leader boards. As opposed to online gamification, AR and VR allow learners to physically interact with points and badges and even hold them in their hands.

3. Customized Learning Paths in Web-based Courses

Unlike the conventional eLearning paths in your eLearning courses, AR and VR will enable learners to literally walk down a learning path and interact with the learning resources. Doing so, you will provide your learners with physical interactions like never before. Much like immersive video games where players go through different paths depending on their performance and failures.

For instance, the assessment in an eLearning course showed that your learner needs to improve on decision-making abilities. Hence, using AR and VR technologies in online training will allow the learner to choose eLearning courses and activities that center on the improvement of decision-making abilities.

4. eLearning Assessments with Visual Feedback

Talking about assessments in eLearning, VR technologies foster the use of branching scenarios, online simulations etc., to enhance evaluation. However, VR software allows recording learner performance as well as tracking the final results. How is it different? Once they complete a course, learners have the option of replaying their performance and see for themselves where they went wrong and how they fared.

For instance, if your learners miss an important step in a process, they can be showed how to perform the step correctly and retake the assessment later. All this in a much enhanced and immersive eLearning environment, leaving no room for doubts or misconceptions.

5. Advanced Learning Analytics in Online Training

Gone are the days when your LMS reports were the main source of gathering learning analytics. With AR/VR technologies in eLearning, collecting data has never been this advanced. Now you can track learners' eye contact to gauge the learners' interest in the training program.

Having these detailed insights will help in developing eLearning courses that gauge learner engagement with greater accuracy and utilize them to make a learner-worthy course. In turn, it leads to an enhanced learning experience that meets your learners' expectations as well as paves way for better ROI.

These are only five of the many possibilities of incorporating AR and VR in eLearning; you can even opt for virtual walkthroughs of your workplace, interactive product demos, problem-centric scenario-based learning, and more.

While VR can deliver the wholesome experience, AR in education can be used as a supplementary tool to textbook learning.

9.3.2. Educational resources

There are plenty of different tutorial videos on Youtube and articles on internet regarding applying the methods of AR and VR in different learning pathways.

9.3.3. Technologies used

Wearable devices include headsets, VR glasses and, in the future, contact lenses. Static devices include mobile devices (smartphones, tablets, etc.), landline devices (TVs, PCs) and head-up displays.

Affordable tools like cardboard VR viewers and Aurasma are making virtual and augmented reality (VR and AR) a practical classroom tool.

While VR is changing quickly, the resources below are a good starting point.

- 360cities: Where do your students want to go? Just type in Rome, Tokyo, London and tour anyplace in the world with a 360-degree view.
- 4D Anatomy: Subscription-based app allows students to explore human anatomy.
- Alchemy VR has partnered with Expeditions to produce experiences narrated by naturalist David Attenborough.
- AugThat: Features a large content-based augmented virtual reality library.
- Aurasma: Free app lets teachers create their own AR auras for their classrooms.
- CoSpaces Edu: Tools and resources that allow students to create in 3D, learn to code and connect with curriculum on a new level.
- Curioscope: This innovative platform has one person wear a T-shirt while the other uses a smartphone to launch the app and learn about the human body in a whole new way.

- Discovery VR: Discovery has added a VR app that allows you to experience your favorite Discovery programs, such as Deadliest Catch or Mythbusters in VR.
- EON Reality: Students and teachers can create a blended-learning environment that allows creators to combine 3D with PowerPoint, notes, sound effects and more.
- Immersive VR Education: Free education platform allows teachers to create their own lesson plans and immersive experiences.

9.3.4. Learning topics and places

VR and AR are used in different fields and for different purposes, such as in architecture, sports, medicine, the arts, the military, the media, rehabilitation and the entertainment industry. However, the use of both technological approaches in education is becoming more and more common, in very different fields and in different modes of education, as part of formal education, for shorter training in business or in e-education.

Teachers could teach subjects such as Physics, Chemistry, and Biology through virtual labs that not just keeps students engaged but also allows them to practice before they can test the experiments in real laboratories. Students of medicine can study the precision of anatomy, learn the intricacies of surgery and simulate medical situations for practice. The use of VR and AR in e-learning is limited, in particular, by the fact that there is little or no hardware available. It's expensive.

9.3.5. Usability condition

Some of the common challenges of using augmented reality technology is that there's a struggle to use the new technologies by teachers. Moreover, not all students have the smartphones capable of supporting AR content. Virtual Reality, on the other hand, faces completely different challenges. High costs of hardware, accessibility and lack of quality content are some of the constraints that have kept VR from being the breakthrough technology in education.

But on the other hand like in traditional home-based education, e-learning can take advantage of the benefits of AR and VR for more authentic and active learning.

The greatest benefit of the immersivness of the virtual environment is the accurate simulation of real situations. The associated use of VR can be useful in public speaking training, physician training, and the like.

9.3.6. 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

One of the main characteristics of S. XXI society is the high speed of the changes taking place in its development. Technological advances, the economy and globalization require a type of education that adapts and prepares people, in their many facets as citizens, consumers and workers for the future of the digital age.

Teachers thus acquire a strong commitment to society, as it is in their hands to provide an education that equips students with the necessary skills that the changing labour market and the time require. Fostering creativity, continuous learning and the spirit of innovation are key tasks for teachers.

For these reasons, educational models must be transformed and give pupils a more active role in their own learning, while teachers must act as guides and support, as well as motivating agents in the education of the new generations.

ICTs appear as ideal tools for introduction into the classroom and for fostering the necessary methodological and educational change. Understood as all the resources, tools and programs that are used to process, manage and share information through technological media, ICT in the classroom can help improve the teaching-learning process.

In terms of tools, technology has generated a great variety of platforms, equipment, systems, networks and applications, among which we can find some truly useful to make the educational process more flexible and enrich in the desired direction.

10.1. Flipped Learning

Flipped Learning is a pedagogical model that transfers the work of certain learning processes outside the classroom and uses the time in class and the experience of teachers to promote other processes of acquisition and practice of knowledge in the classroom.

This teaching method has gained importance in recent years in view of the need to change the traditional learning system to adapt it to current needs. With Flipped Learning you learn by doing and not by memorizing, so it is a revolution in the classical educational system, relying on new technologies and the figure of the teacher as a guide.

In addition, Flipped Learning allows the teacher to better focus on the individual needs of each student, thus increasing motivation and making the most of the potential of each student.

10.1.1. Activities/phases of teaching model

While there are numerous ways to structure a class adapted to the Flipped Learning model, teachers can follow the following steps:

- Properly design the programming: Teachers will have to plan the contents to work, choosing those that manage to motivate the students. This programming must be carried out in accordance with the teaching objectives pursued and the skills to be developed. The teacher will choose the materials and resources and structure the use of the time available, proposing what students should do before, after and during classes.
- Multimedia preparation: the teacher will select multimedia materials as interactive as possible and ensure that students are familiar with their use. In addition, the teacher can prepare a control questionnaire to record if the students have visualized, understood and worked all the materials.
- Distribution of materials: the teacher will make available to his students the materials selected for the learning and will make a temporary arrangement of them for the students to work in them, keeping an individualized follow-up.
- Design of the sessions in the classroom: once the students have accessed the materials arranged by the teacher, the teacher must attend to the doubts or

problems that may have arisen after the visualization and work of the sessions. The teacher must adapt to the needs of each student and design complementary or supportive materials, based on active, inductive and heuristic methodologies, as well as individual and group activities with different levels of difficulty.

- Time distribution: classroom classes should be configured taking into account the work done by students outside school hours and saving time for the resolution of doubts and review of activities. In the rest of the class, both individual and group activities have to be developed, designing activities that require collaboration for the realization of subsequent projects.

Following all these steps, the teacher will encourage learning by discovery through the use of new technologies and will help the student be the protagonist, accompanying and guiding him in his learning, keeping him motivated.

10.1.2. Educational resources

INTEF – Instituto Nacional de Tecnologías: part of the Ministry of Education and Vocational Training, it is the unit responsible for the integration of ICT and teacher training in Spain. It is a meeting place to promote change in the methodology of the classrooms, based on collaboration, improvement of learning spaces, development of skills for the 21st century and digital educational competence.

INTEF develops, promotes and disseminates curriculum materials to support teachers, digital and audiovisual materials in all areas of knowledge and specific teacher training programmes for the development of digital competence through the application of information and communication technologies.

Since its creation in 2013, they have published a total of 94,352 educational resources for teachers in Spain.

A2O – Santillana: it is the first product of adaptive learning in Spanish, which currently offers a pilot experience to experience how new technologies apply to classroom dynamics.

A20 offers options for setting up an inverted class plan with all its own characteristics, offering a very intuitive space in which the teacher can follow his students individually.

It employs big data tools and data analytics that allow storing the historical records of each student to know their skills and deficiencies, define the curriculum that best suits them, and assess the best ways for their professional and educational future.

A20 aims to promote Flipped Learning in Spain and 60 Spanish schools, 80 teachers and 1250 students have already participated in this project.

CATEDU – Centro Aragonés de Tecnologías para la Educación: this autonomous centre is under the Department of Education, Culture and Sport of the Government of

Aragon (Spain) and offers specific distance training for teachers, in addition to services designed to encourage and facilitate the use of ICT in education, extending educational opportunities to sectors of the population previously excluded due to lack of time or due to their place of residence. Since 2003, it has continued to develop with the expansion of the provision of formal, non-formal and teacher training courses.

Espacio Digital Greta: created by the Spanish publishing company Grupo Anaya, this space provides schools with different types of digital resources. It incorporates features that allow the integration of textbooks and other materials used by teachers and students at a single access point. In addition, it provides customized teaching units, resource bank, interactive activities and follow-up.

Thus, in Espacio Digital Greta, teaching and learning processes take place in a technological environment and in a meeting space for teachers and students, which facilitates direct access to digital content and is installed on the server of the different educational establishments.

The Flipped Classroom España: headed by who we could call the guru of the Flipped Classroom in Spain: Eduardo Santiago. Professor Santiago, professor at the University of La Rioja, became aware of this methodology in 2012, and since then he has been the main defender of this methodology in Spain, having written a couple of books related to the subject; the second of which has been as a co-author along with one of the American discoverers of the FC, John Bergman. Likewise, both Professor Santiago and other teachers have developed a website called www.theflippedclassroom.es/ in Spanish in which all teachers who want to participate can join this initiative, even offering the possibility of a certification of use of the FC. This page is one of the main points of interest and information in Spain for the use of the methodology since, on its different pages, you can consult material and ideas for use in the classroom.

10.1.3. Technologies used

Google Classroom: teachers can use this Google tool to manage classes online, whether for face-to-face, distance or mixed learning. They will be able to create documents, share information in various formats and hold virtual meetings.

In this way, students can access their classes, notes or tasks from any device. In addition, Google Classroom allows different tasks to be assigned selectively, which allows the teacher to devote individual attention to each student according to their needs. Of course, this tool increases communication between teachers and students, facilitating more efficient communication channels and feedback delivery.

On the other hand, students can create their own sites with topics of interest to them, share work online and work collaboratively, encouraging an increase in motivation.

Edpuzzle: this online tool allows teachers to edit and modify their own or Web videos to suit classroom needs. It is an ideal application for creating video lessons that facilitate methodologies such as the Flipped Classroom.

After selecting his favorite educational videos, the teacher can edit them and assign them to his students, also allowing the application to check the understanding of these through questions that can be inserted throughout the viewing.

In addition, students can create their own video quizzes to test the knowledge of their peers, thus working collaboratively. Some of the main functions that the teacher can use are to cut and translate videos, create video lessons to learn and review in a simple and fun way.

Panopto: it is a video content management platform that allows recording of classes or conferences from any mobile device and with 3 cameras at a time. Videos are stored in a library and can be sorted by subject and by course. In addition, you can make webcast in real time and interact with students.

It is a platform created by educators for educators, whose main objective is to facilitate education and interactive models such as Flipped Learning. With great flexibility and control, the teacher can obtain very detailed statistics on each of the videos and the activity of his students.

Quizlet: this app allows to create and share educational cards and study units in any curricular matter, through maps, graphs, images and figures. With the different modes contained in this tool, learning is fun, easy and dynamic for students.

The app presents different modes that can be used for various educational purposes; The Learning and Writing mode, allows students to prepare for evaluations, and can even add time tests with the combined mode. For languages, this application includes texts that can be heard correctly in more than 18 different languages.

Through the cards, the teacher can deliver his lessons in a visual, enjoyable and clear way that facilitates learning and can encourage students to create and share their own.

Edmodo: It is an educational platform whose functioning is very similar to that of a social network. There are three types of profiles: teachers, who are in charge of creating the groups and managing them, being able to create groups by class or subject and upload documents, events or qualifications to each of them.

The one for students, who access the group to which they belong by a code and in which they can download files, send documents to the teacher, consult their individual assignments and qualifications.

In addition, students can use the group to raise questions that can be solved by everyone or by the teacher.

Finally, parents will also be able to access the platform with a family code to consult students' activities. In this way, Edmodo ensures smooth communication

between the three groups and guarantees immediate and individualized attention to each student.

Socrative: Through this app, the teacher can create different types of tests to evaluate the knowledge of his students in a pleasant and immediate way.

The tool offers the possibility of conducting questionnaires, with time and ranking results to which students can respond in real time through their devices, so that the teacher can follow the results live and review them later.

A tool as simple and dynamic as this allows instant feedback on how the class is going, be it physical or virtual, a continuous evaluation of the students' knowledge and supposes an increase in the interest and motivation of the class, in addition to encouraging the participation of each student adapting to their communication skills.

10.1.4. Learning topics and places

The Flipped Learning model will help to change traditional teaching practices. Until now, it was customary for the teacher to explain the lesson during the class and give instructions, and during that time the student had to assimilate the information and practice the knowledge.

According to the flipped classroom model, the student must perform these tasks outside the classroom, in an autonomous work through the use of digital technologies, in order to better invest the time in the classroom.

The teacher guides the student in his tasks, receiving instant feedback that allows the teacher to check the degree of access and understanding of these tasks. The student thus becomes the protagonist of his own learning and is guaranteed a personalized attention appropriate to his level of understanding. He becomes an active subject, an actor rather than a spectator in the class because he works, participates, raises doubts, collaborates…

In this way, the teacher can adapt the content of his classes to what the pupils need, rather than just adjusting to the teching material, providing great flexibility in the way a class is composed. In this way, not only is learning tailored to the learner’s needs achieved, but it also generates more interest and motivation.

In the traditional teaching model, it is very common for a pupil to lose the thread of the lesson if he has not correctly understood some concept and therefore lose interest in following the subject. If this situation continues over time and the teacher is not aware of the problem, it is very likely that the student will fail the subject.

All this is avoided with the Flipped Learning model, since the teacher has all the necessary tools to realize how each of his students is evolving and can provide the necessary help in cases such as the exposed one, making the student understand, feels cared for and regains interest.

Recent studies demonstrate a positive correlation between Flipped Learning and the level of learning and understanding of students, demonstrating the effectiveness of this model and the appropriateness of its application in the educational field.

10.1.5. Communication channels

Slack: this is a messaging app designed to work as a team. It can be used in multiple disvositives and platforms and allows talking one by one or in groups. In addition, files can also be uploaded and shared as it integrates other applications and services, such as Skype for video calling.

For all these features, this application is beginning to be widely used for the class, as it allows direct teacher-student communication in real time and from anywhere through any device.

Microsoft Teams offers several different ways to communicate with learners:

- Conversations (Teams – Semi-synchronous).
- Files (OneDrive – Asynchronous).
- Content (OneNote – Asynchronous).
- Outcomes (Planner – Asynchronous).

Conversations, files, content, and outcomes in aggregate offer forms of communication that may be synchronous, semi-synchronous, and asynchronous as well as emerging in and outside of the classroom. The reasoning for using Microsoft Teams (Teams, OneDrive, OneNote, and Planner) is to have options in the types and modes of communication so that as the course transpires, adaptations to assessment and instruction can be made as needed.

WhatsApp: since launching in 2009, WhatsApp has become the world's most popular text and voice messaging application. Specializing in cross-platform messaging, WhatsApp is a free service that lets users message one another seamlessly between mobile and desktop devices.

WhatsApp is known for its enhanced privacy features, such as end-to-end encryption, and its free, web-based international calling. Read on to find out how you can leverage the Facebook-owned messaging giant to make free international calls.

Google Drive is a file storage and synchronization service developed by Google. Launched on April 24, 2012, Google Drive allows users to store files on their servers, synchronize files across devices, and share files. In addition to a website, Google Drive offers apps with offline capabilities for Windows and macOS computers, and Android and iOS smartphones and tablets. Google Drive encompasses Google Docs, Google Sheets, and Google Slides, which are a part of an office suite that permits collaborative editing of documents, spreadsheets, presentations, drawings, forms, and more. Files created and edited through the office suite are saved in Google Drive.

Classdojo is an essential tool for the teacher that not only complements, but also meets one of the fundamental needs of education: to achieve a daily, fluid and constant

communication between the three pillars of the educational system: tutors, students and teachers.

Classdojo offers, through a simple and enjoyable interface, an attractive way of keeping records of students' behaviour and performance in the classroom. But the main objective is to involve themselves and their parents in this task.

10.1.6. Usability condition

There are several studies that show that students prefer Flipped Learning to traditional classes and that they perceive that they learn more and better with this class dynamic. Not surprisingly, as this method improves interactions, both between learners and teachers, access to content and materials, allowing learners to work at their own pace and choose the material that best suits their needs, teamwork and a sense of ownership in learning.

For the teacher, this is an important opportunity to innovate and change teaching in a way that is adapted to the needs of the socio-educational context. It is true that the implementation of this methodology involves a great initial investment of time and workload, both when generating the right material for the classes and when planning them.

During classes, it is important not to saturate students with audiovisual content and at the same time to reinforce the individual attention of the teacher to each student.

To achieve a successful implementation of Flipped Learning in the classroom, it is necessary to take into account a number of aspects such as the following; the average duration of the videos should not exceed 12 minutes in order not to lose the optimal level of concentration and attention of the students.

The explanations should be clear, visual and attractive and should contain illustrative examples. Between each couple of sessions, no more than two or three videos should be displayed to avoid creating saturation.

The teacher must motivate the participation of each one of the students, so that no one goes unnoticed and that all of them study, work and participate in the contents before each face-to-face session.

In addition, the teacher must take into account the total workload of the other subjects to ensure that he does not submit to tasks that overwhelm the student, also considering the pressure moments when the exams or evaluations approach.

Taking these tips into account, the articulation of each class depends entirely on the teacher, providing him with great flexibility and creative freedom in the classroom, so that he can choose the tools that work best for his students and guide them successfully in their learning.

10.1.7. 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

Mobile learning is the teaching process that takes place through mobile devices (smartphones or tablets) connected to a wireless network, thus allowing a more immediate interaction between teacher and student.

The success of mobile learning is due to the constant evolution of mobile technology, since 66% of the world population has a mobile phone, being Spain the leader in the penetration ranking with 88%. The number of mobile devices is expected to reach 16.0 billion worldwide by 2021 (Ditrimedia Report: Mobile in Spain and the World 2017).

M-learning has a well-defined method and particularities, but it is common for it to be considered synonymous with e-learning, although this is not the case. The latter is to use ICT to access educational content outside the classroom so that students can work and study online. On the other hand, m-learnig differs from e-learning in content, time and devices. The content of m-learning tends to deal with non-formal learning for skills, such as emotional intelligence or problem solving, while e-learning is structured around more extensive and formal content.

Normally covering m-learning content is a short and simple task, and while e-learning materials are designed to be seen preferably on computers, m-learning materials look better on smartphones or tablets.

10.2.1. Activities/phases of teaching model

Due to the nature of the devices that will host the educational content, special care should be taken in the design of the courses for m-Learning. Designing courses especially for mobile devices is different from the traditional e-Learning.

The multimedia elements designed must be adapted to the size, dimensions, style, characteristics and quality of the devices; images, types of letters, videos and other elements must be perfectly adapted to mobile devices. In addition, the content must engage and motivate the student, so that it must be clear, concise and useful.

If the teacher wants to include evaluations in mobile courses, he must take into account that due to the nature of the device, the student may be subject to interruptions

and the concentration effort has to be greater. So evaluations should be short and direct, such as multiple-choice test questions or true or false.

In order to implement m-learning in the classroom, it will be essential that the teacher define the learning objective he wants to achieve through this tool, being aware that tenconogy allows the creation of tasks that were previously inconceivable. It is very important to define the technology that is required, and to ensure that each student has access to it (we mean both devices and upgrades) and of course, it will have to be adapted to the skills of the teacher and the students. It is also important to consider connectivity, sometimes it is necessary to have Wifi to carry out some activities.

Finally, it is important to consider that the content exposed through m-learning will bring advantages over and be interconnected with other modes of learning. It should be taken as a support to the rest of the modalities, be it in person, online or mixed.

The teacher must continuously monitor the learning experience of his students, making sure that there is a feedback channel, that the student is adapting correctly to this method and that the experience fulfills its educational purpose.

10.2.2. Educational resources

INTEF – Instituto Nacional de Tecnologías: part of the Ministry of Education and Vocational Training, it is the unit responsible for the integration of ICT and teacher training in Spain. It is a meeting place to promote change in the methodology of the classrooms, based on collaboration, improvement of learning spaces, development of skills for the 21st century and digital educational competence.

INTEF develops, promotes and disseminates curriculum materials to support teachers, digital and audiovisual materials in all areas of knowledge and specific teacher training programmes for the development of digital competence through the application of information and communication technologies.

Since its creation in 2013, they have published a total of 94,352 educational resources for teachers in Spain.

mSchools: this program promoted by Mobile World Capital Barcelona is a m-learning initiative that helps students and teachers integrate digital technologies in the classroom, thus offering new forms of teaching and learning and encouraging the improvement of academic results.

mSchools aims to help students develop the digital skills needed for development in today's society through three focus areas:

- Promoting mobile learning.
- Improving digital skills.
- Building an open environment for m-learning.

mSchools collaborates with the Generalitat de Catalunya and the Barcelona City Council (Catalonia, Spain).

Mobils.edu: this is a programme of the Generalitat de Catalunya (Catalonia, Spain) whose aim is to guarantee the educational success of students and to contribute to the improvement of digital skills by betting on the educational use of mobile devices. Thus, the 2019-2020 school year will be launched a pioneering initiative for teachers and students from up to 100 schools in Catalonia.

The programme is voluntary and lasts three years and will include educational establishments of different types throughout the country.

Mòbils.edu will be based on a BYOD (Bring Your Own Device) model, so that students can bring personal mobiles to the classroom. However, the Department will provide facilities to the centres to fill any gaps that may arise. This plan will also provide specific training for teachers, incorporating new modalities to enhance networking.

10.2.3. Technologies used

Quizlet: This app allows to create and share educational cards and study units in any curricular matter, through maps, graphs, images and figures. With the different modes contained in this tool, learning is fun, easy and dynamic for students.

The app presents different modes that can be used for various educational purposes; The Learning and Writing mode, allows students to prepare for evaluations, and can even add time tests with the combined mode. For languages, this application includes texts that can be heard correctly in more than 18 different languages.

Through the cards, the teacher can deliver his lessons in a visual, enjoyable and clear way that facilitates learning and can encourage students to create and share their own.

Photomath: this mobile application allows you to solve mathematical operations with the camera of the device. It is only necessary to point to the operation for the app to show us the result.

This tool allows you to quickly verify if the exercises have been performed correctly, showing step by step the explanations of how the operation has been resolved.

Kahoot: it is a tool to learn and review concepts in an entertaining way, simulating a contest. The form it uses is through test questions, although there is also the possibility to discuss and discuss. The teacher can create content for the game and successful answers are rewarded with a score that will make up a ranking.

Google Arts & Culture: this application allows access to more than 1,200 museums, galleries and institutions in 70 countries from mobile.

Use free tools like the "Art Camera" that takes a picture of the work at a very high resolution to appreciate all the details, or the "Museum view" which offers a 360º virtual tour inside the enclosures running somewhat like the Street View of Google Maps.

Memrise: ideal app for learning languages from mobile that repeats vocabulary over and over in order to memorize it. Every word or phrase is symbolized by a pot and

when the plant has grown at all, that word has been learned. The methods it uses are listening and writing, plus several videos starring real natives. In addition, the app contains test tests to remember the vocabulary learned.

Teacherkit: it is a simple application that aims to speed up the teaching process by facilitating classroom management. Through it, the teacher will be able to analyse and share information, record attendance and behaviour of students and track all grades.

Onenote is an app for taking notes and making lists that can be downloaded on your mobile and consulted through the cloud at any time. It allows you to organize notes by themes and sections and add images, links, lists and labels.

10.2.4. Learning topics and places

M-learning has a number of features of its own that make it very interesting to apply in the classroom. Some of them are;

- Ubiquity or access possibility from any place and moment.
- Flexibility, as it is adaptable to the needs of each.
- Portability and immediacy; the user can carry his mobile with him at any time and access the information whenever he wants.
- Accessibility, since its cost is lower compared to other digital tools.
- Connectivity and multifunctionality; it allows access to information on the internet and the accomplishment of multiple tasks, also allowing access to apps.
- Personal use; each student has his own and can customize it to his liking.

Mobile learning can be applied for skills acquisition, problem solving, exploratory purposes, language learning or collective work. To this end, it is necessary to begin by proposing a learning strategy adapted to these resources and to create collaborative spaces in which teachers and students are active users. Thus, it is easier for the student to adapt to the system of using mobile devices in the class and these help him to acquire new knowledge and improve his skills.

In addition, it should not be forgotten that mobile learning is a system compatible with other methodologies and very useful for mixed learning, being for the teacher a great tool for students to access complementary material.

10.2.5. Communication channels

WhatsApp: since launching in 2009, WhatsApp has become the world's most popular text and voice messaging application. Specializing in cross-platform messaging, WhatsApp is a free service that lets users message one another seamlessly between mobile and desktop devices.

WhatsApp is known for its enhanced privacy features, such as end-to-end encryption, and its free, web-based international calling. Read on to find out how you can leverage the Facebook-owned messaging giant to make free international calls.

Slack: this is a messaging app designed to work as a team. It can be used in multiple disvositives and platforms and allows talking one by one or in groups. In addition, files can also be uploaded and shared as it integrates other applications and services, such as Skype for video calling.

For all these features, this application is beginning to be widely used for the class, as it allows direct teacher-student communication in real time and from anywhere through any device.

Microsoft Teams offers several different ways to communicate with learners:

- Conversations (Teams – Semi-synchronous).
- Files (OneDrive – Asynchronous).
- Content (OneNote – Asynchronous).
- Outcomes (Planner – Asynchronous).

Conversations, files, content, and outcomes in aggregate offer forms of communication that may be synchronous, semi-synchronous, and asynchronous as well as emerging in and outside of the classroom. The reasoning for using Microsoft Teams (Teams, OneDrive, OneNote, and Planner) is to have options in the types and modes of communication so that as the course transpires, adaptations to assessment and instruction can be made as needed.

Google Drive is a file storage and synchronization service developed by Google. Launched on April 24, 2012, Google Drive allows users to store files on their servers, synchronize files across devices, and share files. In addition to a website, Google Drive offers apps with offline capabilities for Windows and macOS computers, and Android and iOS smartphones and tablets. Google Drive encompasses Google Docs, Google Sheets, and Google Slides, which are a part of an office suite that permits collaborative editing of documents, spreadsheets, presentations, drawings, forms, and more. Files created and edited through the office suite are saved in Google Drive.

Remind: it is an app that allows communication between teachers and students. In addition, the tool can act as a school agenda as it reminds users of scheduled tasks and exams. The teacher can send attachments and voice clips and the student is notified immediately.

10.2.6. Usability condition

M-learning has great advantages in the educational environment, favouring learner-centred learning and in the social context.

Since the use of mobile phones is integrated into students' lives, their use is simple and increases motivation.

Using this tool well, the teacher can facilitate the understanding of the knowledge taking into account the diversity of the students.

Mobile learning allows you to:

- The exchange of data between students and teachers, as well as the direct publication of content and comments.
- Access to warnings, reminders, notes and news.
- Facilitates feedback and mentoring.
- Increase communication by creating new forms of interaction.
- Create scenarios in which students share information and work as a team.
- To encourage research.
- Connect to external applications.
- Facilitate the creation of learning communities focused on specific topics.

On the other hand, it is true that m-learning is more suitable for introducing educational support material than for providing extensive content on a particular subject. Among its limitations as a tool, we can mention that the mobile presents too small a screen, although every time smartphones tend to be bigger. We should also mention the short battery life, although they are becoming more durable, or the limited storage that can be solved by cloud computing.

The teacher acquires a guiding role in the use of a tool like this, as it alone does not deliver results. The important thing is the pedagogical use that the teacher provides to his students, being support of the rest of modalities of learning, expanding the offer of formation and its typology. The important thing is not to innovate with the mobile, but the process of teaching and learning itself.

10.2.7. 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

Information and Communication Technologies (ICT) are an increasingly used tool to enrich the learning process of students at all stages of education. Augmented Reality and Virtual Reality are increasingly being used in the field of education, as can be seen in the Horizon Report. Virtual reality (VR) is a digital environment, created through technology, to simulate reality. The scenes, objects or figures that form these scenarios of virtual reality seem real and the student lives an immersive experience. Creating this virtual environment requires a technological device, usually virtual reality glasses, but

other devices such as gloves or suits are also integrated to improve the experience and interaction with the stage.

This type of technology has various recreational uses, from art to education and training in multiple fields.

Augmented Reality (AR), on the other hand, combines the real environment with an additional layer of visuals thanks to the camera of an electronic device such as a smartphone or tablet. Unlike the VR, it does not try to replace the physical scenario with a digital one designed by a computer but seeks to add information to the reality that the user is living in a specific moment.

This new information layer can be text and images, videos, animations, 3D elements, audios, etc. And you can access it by pointing the device's camera at a specific point in the real plane or superimposed as if it were an interface.

10.3.1. Activities/phases of teaching model

Augmented Reality and Virtual Reality do not by themselves generate learning. As with other ICT tools, for learning to be effective, technological resources must be part of an activity whose design is the responsibility of the teacher.

The potential of both virtual reality and augmented reality for teaching at any educational stage is enormous. They capture students' interest in all kinds of subjects in a novel way and bring to the classroom a more enjoyable experience that encourages immersive learning that leaves a deeper mark on the students.

In addition, these tools encourage the participation and interaction of students, who are more actively involved in their educational process.

When implementing AR and VR in the classroom, there are several recommendations for teachers, provided by the Observatory for Educational Innovation:

- The technology of the equipment must be optimal and in accordance with the requirements of the teaching content. The devices must have appropriate sensors and high-resolution screens.
- Electronic devices used during the class must be comfortable and not cause physical fatigue in the students.
- Connectivity and compatibility between devices must be ensured.
- The level of information must be adapted to the educational level of the pupils, who must handle it easily.
- The student should interact and be part of the narrative that directs the activities, motivating learning by doing.
- The teacher can generate debates on what is observed in the virtual world.
- Topics studied in the classroom can be complemented with tools such as geolocation (GPS) or markers (QR).

- The teacher should foster social relations between his students and collaborative activities.

In this way, the teacher guarantees an optimal use of these tools that will complement the teaching content and strengthen the learning of the students.

10.3.2. Educational resources

Augmented reality and virtual reality are reaching a great boom in the educational context, as it can be a very motivating instrument for students, especially in those subjects that require the learning of theories, systems mechanisms. There are plenty of different tutorial videos on Youtube and articles on internet regarding applying the methods of AR and VR in different learning pathways.

Some examples are:

LearnAR (eLearning with Augmented Reality): this tool achieves interactive learning for students. Allows exploration by combining the real world with virtual content using the webcam. It is a very simple tool because you only need a computer, a webcam and downloadable content that provides the same website. We find various topics in which students can work: geometry, biology, languages.

Magic Book Project: it is based on the use of a hand-held viewer, with which virtual contents can be viewed on the pages of the physical book with which the student can interact. These materials can be applied at any level of education, simply adapting the content to the respective educational stage.

Physics Laboratory with RA Project: this project is based on a series of experiments aimed at enabling students to better understand the concepts of teaching. It has different physics teaching units, in which the student will control through the web the different experiments, in which a real physical system of pendulum, spring and pulley is visualized. Each activity is guided and has different levels of difficulty.

10.3.3. Technologies used

The implementation of AR and VR in the classroom is based today on the use of the following resources:

- QR codes: it is a very simple level AR technology used mainly in textbooks, to show hyperlinks leading to additional information.
- Markers: this is an augmented reality of level 1, which allows to read codes in texts, images or objects to transform the real image.
- 3D models: used mainly in vocational training or in universities. It has an eminently practical purpose, so that the user can visualize or manipulate elements that would otherwise be impossible (cells, parts of the human body, complex mechanisms, etc).

Some of the tools that make these resources available to teachers are:

Aurasma: it is an easy-to-use tool that allows the creation of augmented reality and its visualization, in addition to enabling interaction between users and sharing information directly.

Layar: very similar to Aurasma although one of the main differences are the different versions it offers, allowing more interactivity.

Aumentaty Geo: it's based on geolocated augmented reality. It allows the user with just the download of his App to view the information of the environment having as support the coordinates that provides compass of the mobile device.

Blippar: it allows you to convert any object, place or image into an interactive experience. It has a specific section for education that allows transforming the classroom or educational environment into an interactive learning space. It allows to add games, videos and music to reality.

ANATOMY 4D: allows to observe the human body after printing the markers and activating the application. It offers several layers that allow to remove and put the one that is most interesting to learn or know, as well as all together.

EON Reality: students and teachers can create a blended-learning environment that allows creators to combine 3D with PowerPoint, notes, sound effects and more.

Immersive VR Education: free education platform allows teachers to create their own lesson plans and immersive experiences.

Reconstructme: allows to capture 3D models in real time by pointing with the camera and creating an instant scan.

ZooBurst: it is a digital storytelling tool that allows students to easily create their own 3D pop-up books.

Augmented Class: tool with which the student can configure in a simple and intuitive way several markers that, by focusing them with the camera of the phone, will react differently, as they are programmed.

It supports audio files, video, images and it is even possible to chain several bookmarks so that, scanned together, they show a different result than if they would do it individually.

10.3.4. Learning topics and places

AR and VR are ideal tools for the classroom because they enrich the environment and promote students' communication, access to information in an attractive way and immersive learning.

They can be applied to scientific subjects such as mathematics, biology, physics or chemistry, being of great use in the practical plane, since it allows to visualize the contents through markers placed, for example, in images or texts.

They are also useful in subjects of letters such as history, language or geography, but orienting the tools towards a more theoretical application, for example offering additional information about places, authors, historical events, etc.

Some of the pedagogical tendencies that we can observe already in the classrooms are the following:

Digital Educational Materials: the best example of the evolution of literacy materials are 'magical books' that include markers that activate the visualization of additional 3D information through a digital device. In addition, they can be supplemented with VR materials to provide the student with a full immersion experience.

Gamification: learning through play is a growing trend in education. Through the VR, the student is fully immersed in the game and thanks to the AR any real scenario can be transformed into a playful board, so in a learning environment, competitive or collaborative play dynamics can be incorporated.

Learning based on experimentation: AR and the VR allow students to experiment with the theory learned about certain teaching contents. The student approaches reality through cases to which he would not otherwise have access, such as historical scenarios, simulators of risk situations, etc.

10.3.5. Communication channels

Innorooms VR: it is a VR tool that brings together several people in the same virtual space, specially oriented to education and training. Allows sharing experiences and knowledge with others even at a distance.

10.3.6. Usability condition

VR and AR offer a more emotional and immersive experience to the students, which makes them stay more motivated during the lessons and learn the best concepts that are transmitted to them by the teachers. Students can explore reality from other perspectives, enriching study subjects and preparing for the digital age.

However, in order to be able to carry out its implementation successfully in the classroom, there are certain points to be taken into account, such as that the necessary teaching material is very specific and the devices can sometimes have high costs.

In order to implement it, some centres may not have the necessary budget and may rely on grants.

In any case, the use of these tools in the classroom is a challenge for teachers, who will have to be trained to adapt to new pedagogical methods and how to orient them towards the educational sphere and not to fall into the use of tools as a mere element of play.

It is important that teachers are prepared to orient students towards the learning and assimilation of concepts through technology and not fall into the vague learning that these media can provide.

10.3.7. 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.

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