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CURRICULUM & TRAINING SCHEME

THE HYBRID FUTURE OF SCHOLAR EDUCATION. THE DIGITAL SKILLS WE NEED TO COPE WITH COMPLEXITY. – DIGICOMPLEX

deses3

TOROSLAR İLÇE MİLLİ EĞİTİM MÜDÜRLÜĞÜ 2008

UPT UNIVERSIDADE PORTUCALENSE

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URBAN RESEACH AND EDUCATION

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Introduction

Experts and researchers from academia to industry pay attention to the new frontiers and technologies that would transform future education. Learning should go beyond knowledge acquisition, and learners need to develop twenty-first-century skills while acquiring knowledge, or vice versa. So, new pedagogies, with the support of technology, are needed (Chan, 2020). Virtual reality environments are among areas that have been frequently discussed and used in education environments in recent years. School curricula are an important part of national or regional education systems, and many nations are reflecting on and developing their curricula to address the increasing importance of digital technologies in society. Now is the time to approach teachers and educators with technology products that will help them improve and democratize education (Schachter, 2018).

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With online learning in higher education becoming a global phenomenon, considering learning styles in this new context of globalization with emerging technologies is also essential. Emerging technologies standard in distance education today include massive open online courses (MOOCs), mobile and ubiquitous learning, and virtual reality (VR) (Atiaja & Guerrero-Proenza, 2016; Poirier & Ally, 2020).

It may be necessary to structure an Open Education System that allows for entertainment elements and socialization by shaping the learner's experiences, especially during the technological singularity period, which emphasizes using individual-centered technologies (Şişman Uğur & Kurubacak-Meric, 2020).

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Virtual Reality

CHAPTER I

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1.1 Definition of Virtual Reality

The term “virtual reality” is credited to Jaron Lanier, the founder of VPL Research, in 1984. Virtual Reality (VR) is an advanced human-computer interface that simulates a realistic, fully digital, computer-generated, three-dimensional experiential environment (Zheng et al., 1998). Minocha et al. (2017) define VR as a simulated or real environment in which a perceiver experiences telepresence.

The core ideas of VR are immersion and interactivity. Immersion means blocking out distractions and focusing selectively on the information with which the participant wants to work. Interactivity means the ability of humans to interact with the events in the virtual world. (Zheng et al., 1998). Virtual reality is an entirely digital, computerized, and three-dimensional experiential environment. Unlike classic user interfaces that allow users to view a screen, VR lets the user move inside an experience and interact with a 3D world (Bardi, 2019; Zheng et al., 1998).

1.2 The necessity of new teaching methods, such as Virtual Reality

The term “virtual reality” is credited to Jaron Lanier, the founder of VPL Research, in 1984. Virtual Reality (VR) is an advanced human-computer interface that simulates a realistic, fully digital, computer-generated, three-dimensional experiential environment (Zheng et al., 1998). Minocha et al. (2017) define VR as a simulated or real environment in which a perceiver experiences telepresence.

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1.3 Types of Virtual Reality

Virtual reality's central objective is to place the participant in a virtual environment that gives the participant a feeling of "being there." This requires linking the human perceptual and muscle systems with the "virtual environment (Zheng et al., 1998).

There are three primary categories of virtual reality simulations today: non-immersive, semi-immersive, and fully-immersive. The Heizenrader and The Tech Steam Center introduced these three types of VR as follows:

- Non-immersive virtual experience is often overlooked as a virtual reality category because it is already so commonly used in everyday life. In a non-immersive simulation, only a subset of the user's senses is stimulated, allowing them to stay aware of and control their physical environment. Non-immersive virtual reality systems rely on a computer or video game console. Typically found in conventional desktop and input devices like keyboards, mice, and controllers. A video game is an excellent example of a non-immersive VR experience.
- Semi-immersive virtual experiences provide the user with a partial. It will still make users perceive that they are in a different reality when focusing on the digital image. It also allows users to remain connected to their physical surroundings. This category of VR is often used for educational or training purposes Semi-immersive simulations run on high-performance computer graphics systems and provide realism through 3D graphics. More graphical detail in a more immersive feeling is often combined with large-screen projector systems or multiple television projection systems to stimulate the user's imagery properly.
- Fully-immersive virtual provides the most immersive implementation of virtual reality technology and gives users the most realistic simulation experience, which is completed with sight and sound. In a fully immersive simulation, hardware such as head-mounted displays and motion-sensing devices stimulate the user's senses. This type of VR is typically adapted for gaming and other entertainment purposes, but its use in other sectors, namely education, is also increasing. To interact with fully-immersive virtual reality, the user needs the proper VR glasses or a head mount display (HMD). VR headsets provide high-resolution content with a wide field of view.

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1.3.1 Software and equipment related to Virtual Reality

3D virtual reality software and headsets can provide high levels of immersion and presence in virtual environments and evoke natural emotional reactions. These have been used for educational purposes for many years. Perhaps the best well-known virtual environment is Second Life (SL) which has been used widely in Higher Education institutions (Molka-Danielsen & Deutschmann, 2009). For example, haptic technologies provide a new level of immersion in virtual environments that has the potential to be exploited in education and training applications (Themeli & Sime, 2020). In the analysis by Yildirim et al. (2018) of the general opinions of participants toward VR glasses and the contents that were provided with them, all participants (100%) included in the study stated that they liked this technology very much.

1.4 Using virtual reality in educational systems

Today's education environment increasingly offers immersive experiences that help children, teens, and adults genuinely enjoy the process of learning. These technologies could help learners be more effective than traditional classroom methods by overcoming language barriers and adapting to visual learners (Schachter, 2018). Virtual reality is an example that clearly illustrates the utilization of new technologies, which provide opportunities to promote lifelong learning (Tosik Gün & Atasoy, 2017; Özdemir et al., 2018).

Virtual environments can support team roleplay in training, where it is essential to have environmental and visual cues that set the scene for the communication activity (Jaeger & Helgheim, 2009). In addition, the adoption of virtual reality for outside classroom activities allowed learners to immerse themselves in virtual situations to create context awareness for better comprehension of conceptual issues like academic integrity (Law et al., 2020).

The literature review shows that VR supports constructivist learning principles (Bani-Salameh et al., 2017; Huang et al., 2010; Katz & Halpern, 2015); hence, learners that utilize VR would be equipped with the capability to process and control various learning-related activities. They have ultimate control over where and when to explore learning (Alalwan et al., 2020). In addition to enabling educational "travel," VR has been shown to improve motor skills, enhance imaginative play and thinking, and inspire learning through gamification (Schachter, 2018).

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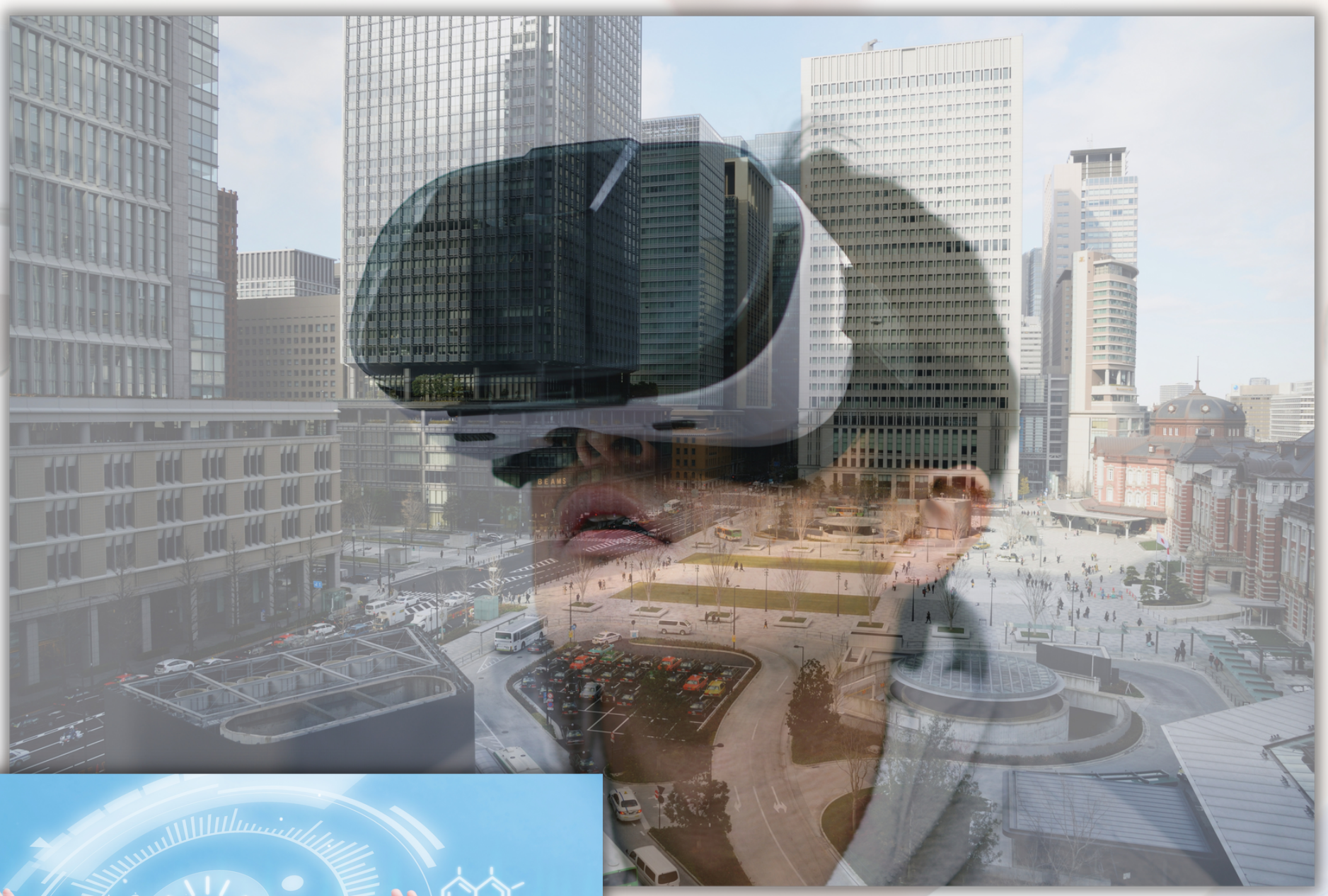
1.4.1 Educator and using virtual reality

Professionals can communicate, exchange information, and progress through collaboratively learning with and from colleagues worldwide. Educators can utilize an intelligent environment to broaden their learning space using mobile devices as hardware, virtual reality as software, and the Internet (Aker & Pentón Herrera, 2020).With this structure, mega universities that will offer learning services will also be able to follow the learning data and provide content integrated with the appropriate learning management system and can provide effective communication as well as interaction (Şişman Uğur & Kurubacak-Meric, 2020).

Findings indicated that most teachers were interested in teaching science subjects using VR in the future (Alalwan et al., 2020). For example, virtual field teaching improves accessibility when it is difficult to physically go to an environment due to climate, terrain, or school resources (Tutwiler et al., 2013).



1.4.2 Students and using virtual reality

It is believed that exposing students to computer-simulated environments may make science learning effective (Chen et al., 2019). It is because combining actual and virtual environments would result in mixed reality, providing learners with a wide variety of exploration options (Correia et al., 2016).VR is a tool that could provide opportunities for students to understand the learning concept by providing a wide range of learning resources (Alalwan et al., 2020).

VR can help students feel immersed in an experience, delivering interactions that are neither practical nor possible without VR, like experiencing historical events or doing a scientific experiment. Adding VR to traditional teaching enhances and extends how students learn and develop (European Commission, 2021). For instance, students can control the pace of their movement in a VR environment. They can communicate with friends through a network and determine the following action to be performed after the communication (Fowler, 2015; Ha & Fang, 2018). Melissa Pelletier, MDR's education research editor, observes, "VR is the perfect vehicle to help students put themselves in others' shoes. Kids of all ages could benefit from experiences that require them to work in teams. Social-emotional skills like empathy are valuable both within the classroom and throughout life. They may not be written into the curriculum like history or math, but they are equally important." (Schachter 2018). Moreover, virtual reality can help students bring experiences to life through animation, physics, and spatial audio (Grimus, 2020). A digital model of the material world allows for a reconceptualization of matter, agency (Choat, 2018), and how students can learn by experiencing a real versus the virtual material world (Tilhou et al., 2020). Learners enjoyed learning through VR because they could experience activities that they could not otherwise experience in a classical classroom, such as creating virtual explosions (Schachter, 2018). For example, the researchers found that when students visited the physical site after using EcoMuve, and upon viewing the real pond in nature, it was evident that the students could transfer aspects of the virtual experience to their observations of the actual material pond. The transfer of learning was apparent in the questions students posed, the information they sought, and how their attention was focused (Tilhou et al., 2020).

Many educational applications are being created with these technologies that focus on applying critical thinking skills to real-world problems. It helps students see how to take these skills into the workplace and make their learning more relevant (Schachter, 2018). VR is an example that clearly illustrates the utilization of these new technologies, which provide opportunities to promote lifelong learning (Tosik Gün & Atasoy, 2017; Özdemir et al., 2018).

Studies show that students would be interested in VR, which may motivate them to learn; VR is a tool that could provide opportunities for students to understand the concept by providing a wide range of learning resources. "If they learn fast, then their [achievement] would be significant." (Alalwan et al., 2020).

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1-4-3- Disadvantage and Obstacles of using VR

The significant challenges that hinder digital technology adoption in teaching are the need for teacher performance of digital technology skills and the unwillingness to adopt them in their classroom practices. Educators need to develop wireless communication and digital learning tools skills. One of the significant challenges for VR is that most students and educators cannot use VR properly (Alalwan et al., 2020). Although virtual reality environments can provide a sense of presence and immersion in the environment, however, it is much more difficult to transmit honest signals (Themeli & Sime, 2020). It indirectly reflects that teachers must be updated and trained on various educational technology practices. Besides that, if parents resist educational technology, students will have lesser exposure to VR. School administrators could also be informed of this, and they could further explain the benefits of VR to parents. It further implies that state education departments, district education offices, and schools should offer more related courses to refine teachers' VR skills and knowledge.

In the studies by Alalwan et al. (2020), based on an interview with 29 science teachers, the primary challenges of using VR in schools included: Lack of parental support; Health impairment; Lack of practice; Lack of guidelines; Lack of competency; Limited instructional design; Lack of focused attention; Lack of time; and Limited environmental resources. Of all challenges, the "Limited environmental resources" was the more alarming challenge than others (Alalwan et al., 2020). Besides all challenges, the widespread integration of machine intelligence "MI" across learning environments may render the face-to-face (f2f) and distance education (DE) contexts immaterial (Aoki, 2020; Simonson et al., 2011). Understanding the challenges of using VR and AR in teaching science subjects would ultimately provide the means for educational policymakers to suggest the necessary measures to reflect upon the current trends, experiences effectively, and practices to support and build capacity for educational change (Alalwan et al., 2020).

1.4.3.1 Educators and lack of digital technology skills

There were many challenges teachers faced when delivering science subjects with VR. Several school teachers have been criticized about being less concerned or slower to recognize the potential of using VR (Aziz et al., 2012). For many educators, there needs to be more clarity between the technical skills that curricula often prescribe and the practical strategies required to integrate these skills into their broader classroom activities (Parsons et al., 2020). Lim et al. (2006), stated that using VR for learning science implied that more time is required for learning a given topic compared to the chalk-and-talk method. Moreover, the lack of active participation in VR minimizes its effectiveness among teachers, which can be attributed to their limited operating skills (Alalwan et al., 2020). It can be reasoned by the fact that average teachers may not be inclined to develop 3D VR models because they need to gain the. For instance, teachers' perceptions of requirements for effectively using VR were considerably more challenging to comply with (Baragash et al., 2020; Baragash & Al-Samarraie, 2018).

1.4.3.2 Virtual reality and some impairing

Some teachers expressed that VR is a tool for independent learning. The student must be a strong self-initiated learner. Otherwise, the students will get bored quickly. Also, educators are concerned about the content of some technology. For example, in VR, students can access anything, and teachers do not want them to access unrelated topics. Teachers' general belief that VR could impair a user's health is another obstacle to its utilization. Students who spend more time on in-world activities than real-world activities are considered addicted to VR (Alalwan et al., 2020). It is supported by Boellstorff (2015), who stated that a few Second Life residents might spend several hours acquainting themselves with other people there. In addition, VR has the potential to result in eyestrain and cybersickness (Park et al., 2017).

1.4.3.3 Deficiency of technology and infrastructure and facilitie

Virtual reality requires an equipped environment to be used effectively in schools (Alalwan et al., 2020). There are still many obstacles and challenges faced in translating virtual reality technology into high-speed networks, and the internet connections in many schools need to provide a stable bandwidth to effectively use VR (Zheng et al., 1998; Alalwan et al., 2020). There are also some problems with charging issues (Schachter, 2018). When entire classes in schools use VR simultaneously, these technical problems would be a significant issue (Alalwan et al., 2020).

Reinhold et al. (2018) stated that a lack of structural school-level factors, such as material resources designed for STEM (Science, technology, engineering, and mathematics) subjects, can potentially reduce STEM quality teaching, thus affecting students' orientation about the subject. Even though educators have made efforts to innovate many teaching and learning approaches to facilitate technology integration in various learning contexts, some challenges remain with incorporating appropriate pedagogy to leverage wireless communication and ubiquitous learning technology (Elsafi, 2020). It is because emerging technologies such as mobile devices are not designed to use as educational tools. Therefore, not surprisingly, their adoption in schools or universities is likely to present some challenges.

1.5 Virtual reality as an education tools for schools

Many teachers believe virtual reality is suitable if it is provided to upper primary students only because lower primary students are too young to use it. Because they believe VR is for those students who are skilful in technology and communication, those that already know how to use a computer. Furthermore, currently, children are very good at exploring (Alalwan et al., 2020).

The experiences of students in higher education with VR showed that the students struggled to use VR. The students represented a range of backgrounds, from no experience to extensive practice with video games and mobile apps. Despite the usefulness of these platforms, selectivity still needs to be plaguing the use of VR (DePape et al., 2019).

1.5.1 Good practices and applications of VR in schools from some countries in the world

The concepts of virtualization for facilitating learning have become the focus of attention in many countries. In Europe, in January 2021, the world's first educational virtual reality theme park was opened. The park consists of six educational Virtual Reality (VR) areas, covering different aspects of the educational curriculum. Using a web-based learning platform, students can consolidate and review what they have been learning during their virtual visit. Besides virtual reality in learning in Europe, there is the VR@School project, derived from the Erasmus program, which aims to promote VR in European classrooms (European Commission, 2021).

Virtual reality headsets to be used in 10,000 schools in Europe. This all-in-one VR headset is specifically designed for school students, preloaded with more than 500+ education modules suitable for grades 6 to 12 for subjects like Maths, Biology, Chemistry, and Physics. Each module contains; an objective learning outline, An active learning session focused on a critical concept, Formative assessment. In 2021 Polish Ministry of Education launched a significant subsidy program for Polish primary schools with an approximate budget of 250 million USD. Schools participating in this program can buy new technologies such as 3D printers, education robots, soldering stations, VR, and other hi-tech equipment. The program aims to provide students with the opportunity to learn to program, modeling, and prepare them for the challenges of the modern world. (DPVR, 2022).

Some research indicates that most of the students in Primary In Turkey Schools are aware of VR technologies; very few stated that they had previously used the current technology. (Yildirim et al., 2018). The study of earth science and geography is among the topics paired with various 3D VFTs employed in studies. For example, in some studies (with the same population and context), Taiwanese tenth graders used Virtools to virtually visit challenging terrain at high altitudes to explore the geological features of the Hsiaoyukeng Walking Area within a remote national park in Taiwan. Students could review geological concepts and explore rocks and weather patterns through virtual experience (Lin et al., 2011; Melinda Lohan, a Massachusetts high school teacher, has been conducting virtual field trips for three years and reports, "The kids love them." Introducing technology has changed what happens in her class. In this way, students watch lectures and take notes at home to get immersed in these learning experiences during school hours (Schachter, 2018).

1.5.2 Virtual Field Trips and General VR Apps

Some Virtual Reality content applications are great tools for educators to explore with their students. These tools provide a VR or 360-degree experience for primary, elementary, and secondary students. Here introduce the most popular resources that are available online and are either free or paid (Paid content is often supplementary to the application itself):

- Google Expeditions and Google Expeditions Pioneer Program (free): Its content is designed for classroom learning. Students and educators take immersive virtual expeditions that allow the teacher to guide students as explorers.
- CBC VR (free): It offers educational VR experiences through documentaries produced by CBC and mainly used for Canadian content.
- EON Reality - Education (free & paid): It creates immersive experiences and promotes experiential learning in higher education. A wide range of subjects is available to improve creativity, critical thinking, problem-solving, and communication in and outside the classroom.
- Nearpod s: It is a widely used tool combining VR with traditional lesson plans. It offers virtual field trip experiences where students can learn about historical sites worldwide. It has numerous educational materials for students 14-18age with various school subjects.
- NYT VR Virtual Reality (free): It is an app on mobile that allows learners to experience stories in an immersive 360-degree video experience. Students can unwind by the "California coast" or climb to the "One World Trade Center."
- Sesqui VR (free): It offers experiences by indigenous 360-degree of Canada's arts and innovation scene. It is contained immersive full-screen experiences, including virtual storytelling, interactive games, and learning resources.
- Unimersiv (free & paid): It is an application available on various VR devices and platforms that provides educational experiences to students and educators. Virtual reality allows students to examine many topics, from history and space to human anatomy.
- Veative (free & paid): It develops 3D, virtual, augmented, and mixed reality educational technologies to enhance learning experiences for students 14-18age and higher education. Its content is adapted to suit all classrooms, curricula, and languages.
- Youtube 360 Videos (free): The official VR channel of YouTube supports uploading and streaming 360 videos on mobile devices and in a computer browser. For a more immersive experience, learners can watch videos with VR headsets.

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Besides the application that mentioned above there are Web-Based VR Creation tools included:

- Cospaces Edu (paid) “Adaptable to any age or subject, CoSpaces Edu lets kids build their 3D creations, animate them with code and explore them in Virtual. Prepare kids for their future while empowering them to become creators.”
- InstaVR (paid): “It Launches Academic Organization-wide Tier Pricing to Accommodate Distance Learning and Campus Virtual Tour Needs Universities Can Give All Professors and Students Access to Create and Distribute VR For Distant Learning and Campus Virtual Tours with a Single User Cost.”
- Thinglink Education (free - basic): “It is for teachers and schools that make it easy to augment images, videos, and virtual tours with additional information and links. Over 4 million teachers and students use ThingLink to create accessible, visual learning experiences in the cloud.”
- Vizor VR (paid): “A full-featured web-based 3D editing and prototyping tool with visual scripting. The simplest way to create and share React VR experiences on the web and social media.”

Glossary

Abbreviation	Description
DE	Distance Education
EcoMUVEs	Ecosystem Multi-User Virtual Environments
F2F	Face-to-Face
MI	Machine Intelligence
M-Learning	Mobile learning
MOOCs	Massive open online courses
SL	Second Life
STEM	Science, technology, engineering, and mathematics
VPL	Virtual Programming Languages
VR	Virtual reality

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CHAPTER
11

Design of interactive animations and 3D modeling

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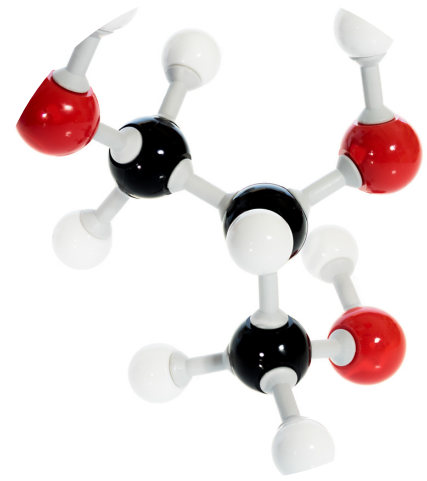
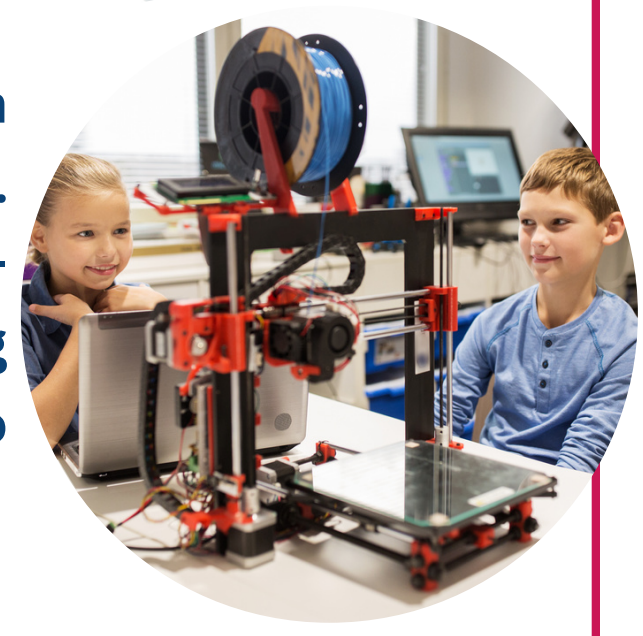
2.1 Introduction of 3D modeling/motivation/requirements

Why to use animated 3D designs in the classroom?

What does the term "3D modeling and design" imply in the digital world? One can say those 3D models are digital creations or objects that are designed by manipulating polygons, edges, and vertices in simulated 3D space. They are, therefore, intangible, yet they can be made tangible with the use of a 3D printing system.



The truth is that when someone encounters terms like "3D models" and "animation", she or he will automatically connect them either with software for architects and engineers or—more often—with the gaming industry. ?



Nevertheless, 3D modeling with (or without) animation ravishes children and may keep them engaged in learning. Let's just consider why almost every kid—or even adult—craves(!) to play those modern video games. So, why not bring to class some of the principles that make computer games so attractive?

Besides being fancy and amusing, 3D models present several other advantages that may benefit teaching and enrich our course materials:

- First of all, one can handle and manipulate a digital "object" without danger of damaging it. Suppose you teach ancient technology and you need to demonstrate the use of a real water clock to 15 or 20 teenagers. How possible is it that it will survive in their hands? On the other hand, if students watch and experiment with the digital 3D model of an hourglass each one in his/her computer lab seat, using only mice and keyboards, we have no such worries, plus zero expenses.

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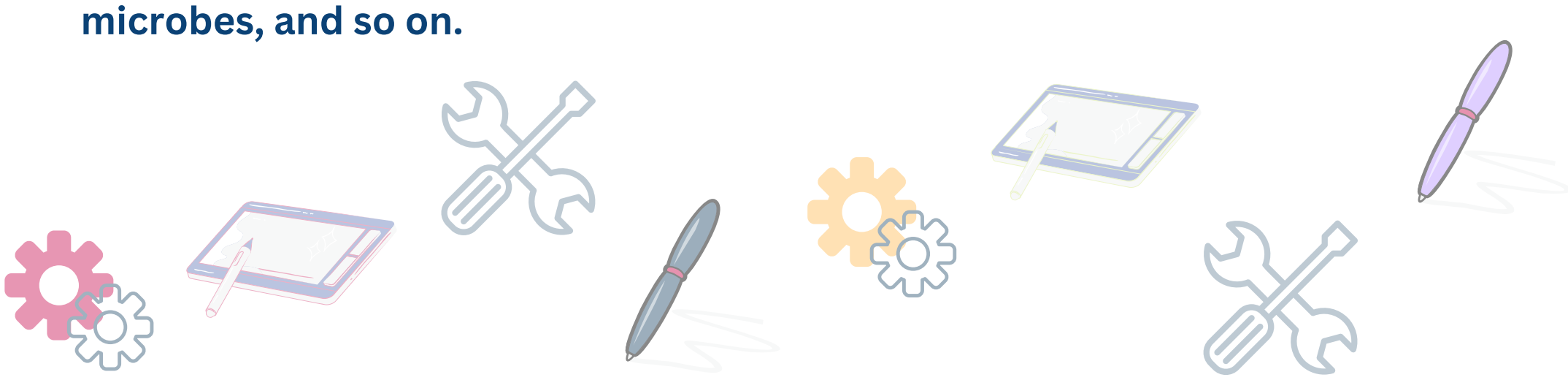
- 3D models are easily duplicated and shared, giving students unlimited time with a specimen. Let’s say you have a biology class, and you want all 20 students to examine human skull morphology. How easy is it to find at least 20 skull mock ups to hand to your students? Or how much time would each student have to physically examine the only effigy of a skull in your lab? If that same skull was instead scanned and made into a 3D model, each student could examine it simultaneously, for as long as they needed.
- A 3D model is a media object. This means it can be examined, but it’s special in the way that it can indeed be interacted with. Functionality can be built on and around a 3D model. Models can be manipulated, animated, and scaled. A photograph captures the light bouncing off of an object, which is closer to a description of the object. A 3D model is a representation of the actual physical properties of the object, and that strikes at the nature of the object itself. This means that a 3D model can "stand in" for a real object in simulations (especially if it is made tangible through 3D printing) and the laws of physics can be applied accurately. This realistic depth and spatial presence can be very impactful for students. much more than a simple photograph.
- Finally, 3D models can be analyzed. Because 3D models are accurate and occupy no physical space, they lend themselves to analysis techniques unavailable in the physical world. Two models can be literally laid on top of one another to highlight any differences. Measurements of structures can be taken with a few clicks. In the case of a machined part, material stress tests can be run over and over without the need to replace the part.
- To put all the above in a nutshell, we can say that 3D modeling has become essential in education because of its effectiveness in keeping students’ attention. 3D illustrations are highly interactive, while most kids today are visual and have a short attention span. So, it’s more convenient for them to not only listen to the teacher or look at the sketches but also discover everything using a visual 3D animation. The retention of the information learned during these sessions will be high. It is especially crucial if the objects teachers talk about are unreal, do not exist in real life, or people are unable to watch them without using special tools. e.g., the Greek mythology of Hydra, dinosaurs, large molecules, microbes, and so on.



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2.2 Good practices /applications in school per each country

Are there any schools worldwide that utilize 3D modeling and animation in the classroom today?

Perhaps you believe that there are, especially in the United States. There are even qualitative reports concerning the advantages of 3D animation in education programs, e.g., in school districts located in Colorado and North Carolina (https://is.gd/QLfdjg). The University of Massachusetts in Amherst also conducted a survey (Maloy, 2017), which showed that several high school teachers used 3D modeling constructs to teach four 8th grade topics with great success: World Geography, US History (two projects), and American Government & Civics. (See table 1 below), recovered from the very survey (https://is.gd/v1lnNX). We'll just mention that the printed 3D models were designed by students in TinkerCAD.

Table 1
3D Printing Projects

Participants	Project	Topic	Curriculum Connection
In-service teacher and preservice teacher	Water Conservation Technologies	World Geography	Oil and water in the countries and economies of Central and South Asia
In-service technology teacher, school librarian, and preservice teacher	Native American Dwellings	U.S. History	Interactions between native people and European settlers in Colonial America
In-service teacher and art teache	Hidden Histories & Missing Monuments	American Government&Civics	Use of memorials and memory in building civic understandings
In-service teacher and preservice teacher	American Revolution Board Game	U.S. History	Events leading to the American Revolution

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One can also find references to good practices like the ones described above about schools in the UK, where even more sophisticated (and thus expensive) equipment was used, e.g., 3D scanners and 3D hologram projectors (Monahan, 2010). A major survey conducted by Dr. Anne Bamford in seven European countries also discusses the advantages of using 3D animation and modeling in the classroom. The white paper can be found here: https://is.gd/0GcZiq.

We also know about schools in Greece where teachers use 3D models made by TinkerCAD or similar software to help students understand the principles of mostly science topics. In fact, even several decades ago, one could find in Greek primary schools' real models, mock-ups, and appliances used to teach physics and astronomy. Below, we present a very rare apparatus like this, used even before 1990, to demonstrate how the shape of our planet changes from a spheroid to an oblate ellipsoid due to the centrifugal force generated by revolution.

Today, most of these models have been replaced by computer simulations and 3D animations, which have the previously mentioned advantages. This transition to the "digital world" might be quite easy and straightforward in some cases, especially if one has access to the actual material model and a 3D scanner. That is one of the things we will discuss next.

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Where and how can I create or find 3D designs to animate and use in the classroom?

There are plenty of 3D modeling software tools from which one can choose in order to create his or her own classroom demonstrations. First of all, anyone can find several ready-made 3D models in various repositories such as 3DWarehouse, Sketchfab, TurboSquid, and the open one of the Smithsonian institution. Of course, you can also use programs/platforms like TinkerCAD, Doodle3D, Meshmixer, SketchUp, or even professional tools like Blender and Unity (which is commercial) to build your own animations. Most of them offer open access, but we would suggest TinkerCAD because it is platform-independent (i.e., Web-based; you only need a browser to run it), and it is completely free. (Here, "free" is used as in "free society," not as in "free beer"). Doodle3D is also an easy-to-use, simpler, lighter, but more "naive" alternative.

At this point, we should take a "break" and clarify something: we really think that 3D modeling and animation can enhance teaching to a great extent, but we also do not expect teachers or students to become artists or professional designers in 3D. We have to be realists. The average teacher (or worse, student) cannot design a decent three-dimensional illustration of a T-Rex head or perhaps the Parthenon pediment without the appropriate (and time-consuming) training. In other words, we won't describe here how someone can create or draw a specific 3D model and animate it. Besides, this procedure depends directly on the software and other tools used.

Thankfully, there are also hardware tools that can save us a great deal of time while trying to render our own 3D models. We're talking about 3D scanners here. A 3D scanner does with real objects what a usual 2D scanner does with photos and text: It reproduces them digitally. Simply put, one can use a 3D scanner to scan a real statue or, say, a skull, a figurine, etc. and have it as a digital 3D model in a jiffy. Then a 3D printer can be used to reproduce what we see on a screen as a plastic artifact, or we can keep it this way (on-screen only) to display or edit (!) using software like the above mentioned. The picture below is an attempt to demonstrate how 3D scanners are used briefly.

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Two things to keep in mind, though: First, 3D scanners and printers are still very expensive, and second, their usage is not very simple (to put it nicely). Some training is required, especially when it comes to the various angles one has to choose if she or he is to scan a 3D object. You see, in some cases, if the angles are not wisely chosen, then the software is supposed to "decide" how one face or the other should look. So we might come up with a three-legged Sauropod, an angel with a single wing, a semi-bald Aristotle, a ram head with horns of many different sizes, and so on.

Ok. I've got the tools. Now what?

Now it's time to talk about: Connecting 3D modeling and animation with the school curriculum. Some high school examples.

2.3 How to connect 3D modeling with the curriculum and with primary and secondary schools

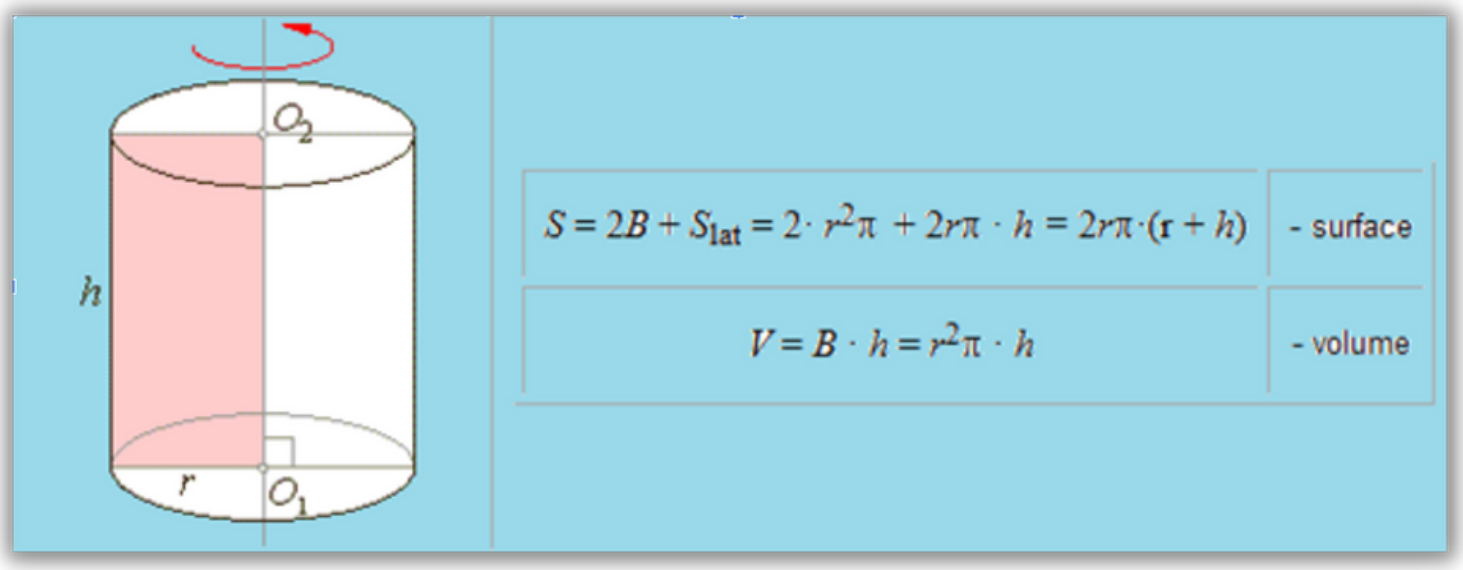
One can devise numerous ways to utilize animated 3D models in the classroom. For instance, 3D models (animated or not) are used in some schools to prepare children for visiting a museum, or perhaps their use is directly connected with history or biology, but mostly technology-related curriculum. For instance, Digital 3D representations of ancient structures like the Colosseum in Rome or the Parthenon in Greece can be easily adopted in history lessons. A homo nearderthalensis skull model can be used to demonstrate parts of the theory of evolution, and an Enigma cipher machine model could be utilized while teaching cryptography or even the history of Computer Science and so on.

Here, we shall demonstrate some practices that connect the above to the (mostly) secondary school curriculum:

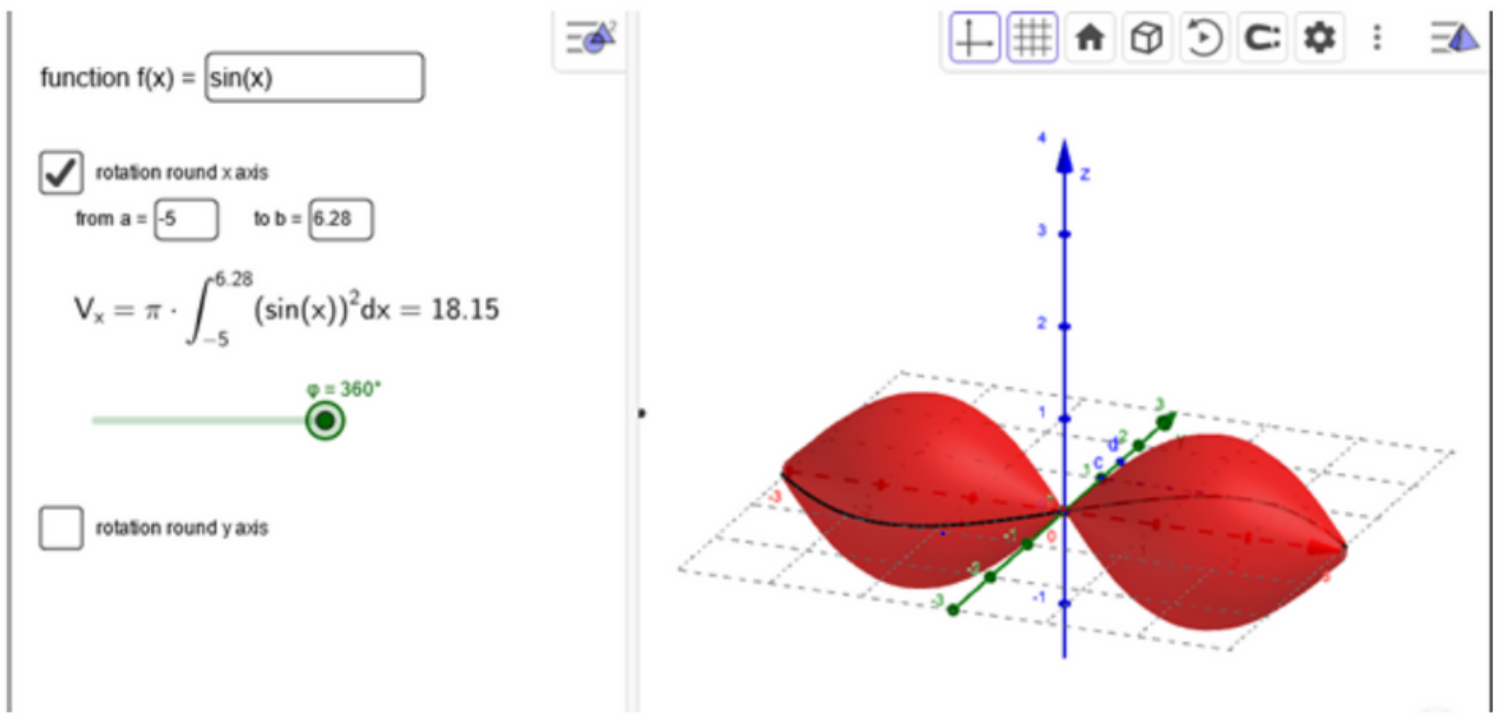
1. Use 3D modeling (and some animation) to teach the Maths of solids of revolution (i.e., cylinder, cone, and sphere).
2. Space Physics and Astronomy: Teach about how our moon formed billions of years in the past.
3. Digital 3D animations and simulations that explain some functions of the world's very first computer: The Antikythera Mechanism.
4. Display how the parts of ancient pillars in pre-Christian Greece or in some Aztec structures were hinged to each other by lead.
5. Modern 3D video games in the classroom!

A Math class: Solids of revolution

As any math teacher knows, there are solids (i.e., three-dimensional shapes) that can be "produced" by revolving rectangles or other two-dimensional shapes. For instance, if you revolve a right triangle around the y axis, a cone appears. A sphere is produced by the revolution of a circle with its center located on either one of the axes; a revolving rectangle creates a cylinder; etc. These constructs are therefore called "solids of revolution". In fact, we can take advantage of the observations above to easily calculate the surface area and volume of such solid. Figure (a) below demonstrates this.



We can use 3D modeling software to produce simulations that do teach how calculus (and especially integrals) can help determine, say, the volume of more peculiar solids in a revolution. We think that Geogebra is another excellent, free tool for this purpose. For instance, a teacher can ask students to visit: https://www.geogebra.org/m/zBRtUVfR and play with the curve equation, revolution extent, and the limits on the axes to see that any volume can be calculated. Just let students test: f(x)=sin(x), α between [-2π, 2π], rotation angle φ=360oand leave only "rotation round the x axis" checked to compute … the size of a bra. The interaction here is introduced quite simply by changing some input field values.



Similar or even more sophisticated demos can also be produced with Wolfram System Modeler, which is proprietary (commercial, non-free) software. The same holds true for another geometry-tailored 3D design application under the name Shapes 3D, but this too is proprietary software.

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Astronomy: How was the moon formed?

Most scientists today accept the plausible hypothesis that the moon formed when a planet, perhaps the size of Mars, smashed into early Earth. So this is the prevailing theory, which is usually taught in schools. Remember, though, that we're talking about something that happened almost five billion years before, where even the nature and form of our planet were completely different than it is today. It must have been much more liquid—somehow runny, to say the least. Therefore, the only way to present it to students is by using a 3D simulation of the event. Now, imagine that such simulations were absolutely impossible some decades before. Thus, it might have been very difficult for children to grasp this theory only by hearing a description of it.

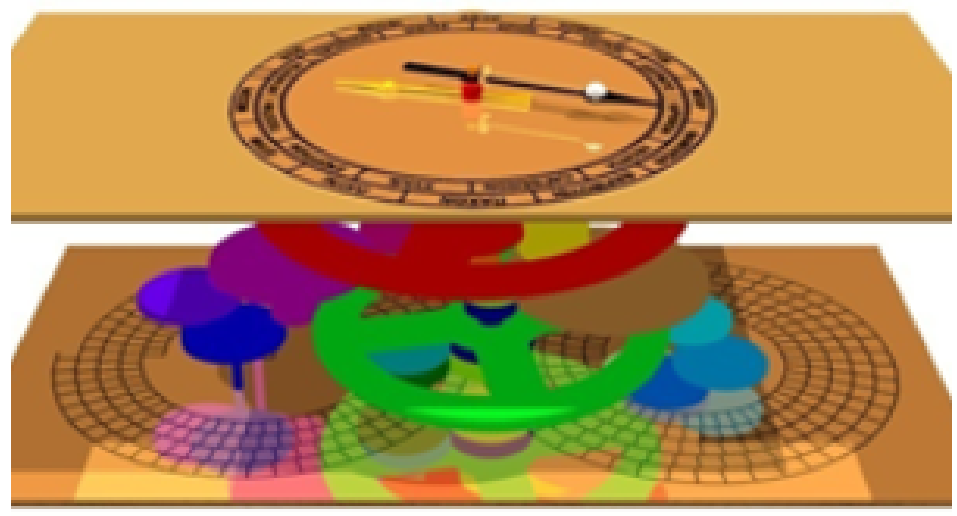
Fortunately, modern supercomputers are powerful enough to allow for simulations of planetary collisions that make them much more understandable to students. On the other hand, a teacher cannot design and implement such simulations because of the enormous computing power required (at least if you wish to present something precise and realistic). Thankfully, several ready-made demonstrations exist on the Internet, which beyond being quite impressive, are also self-explanatory. Moreover, it is easy to download some of them and share them with your students.

Demonstrate and explain ancient technology: The Antikythera mechanism

As we read in Wikipedia, "The Antikythera mechanism is considered to be the oldest example of an analog computer ever discovered (1901, in a shipwreck quite near the island of Antikythera, Greece). It is an Ancient Greek hand-powered orrery used to predict astronomical positions and eclipses decades in advance. It could also be used to track the four-year cycle of the ancient Olympic Games". Unfortunately, as one could expect, it is very hard for anyone to understand the way it works, let alone explain and/or demonstrate it to an audience of teenagers.

A part of the real artifact

That, of course, without using 3D modeling and the work of Dr. Manos Roumeliotis, faculty at the University of Macedonia, Greece. You see, after years of study, Prof. Roumeliotis has developed several 3D models and simulations that help us transcend from findings like those on the left image to the real working apparatus like that on the right image.



3D model of the whole artifact (©Manos Roumeliotis)

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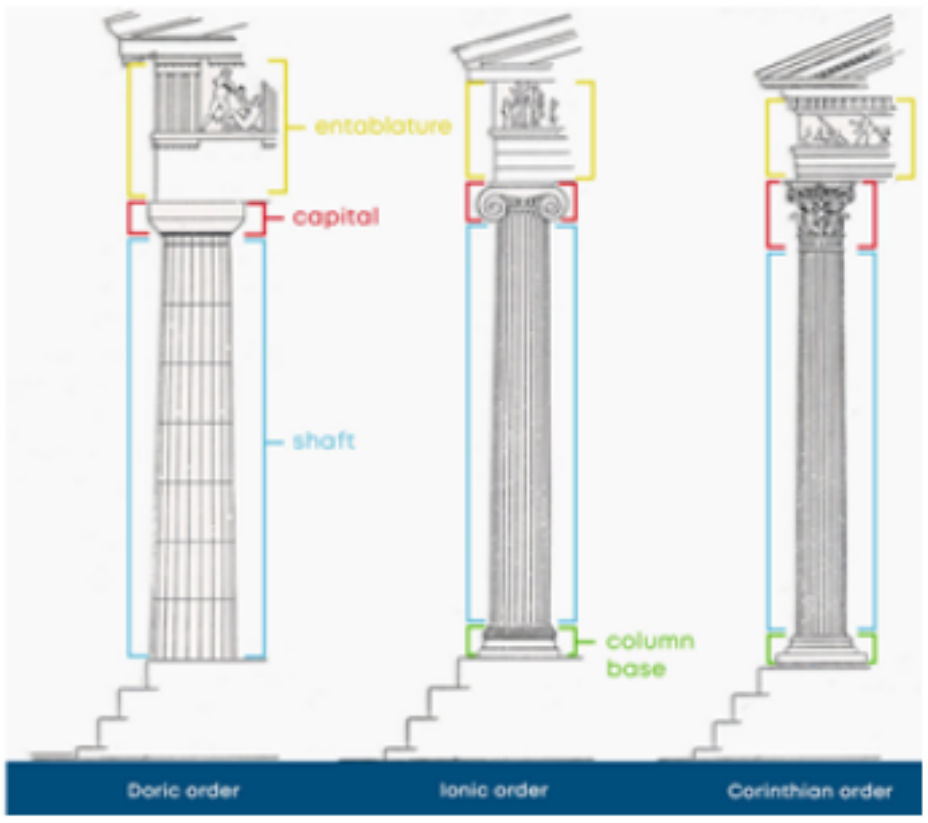
Those 3D models and animations that simulate the machine are free to study at Dr. Roumeliotis' site. Especially the simulation found here is quite interactive (thanks to a bit of C++ programming). Should anyone study them, she or he will find attractive paradigms that teach a lot about how the ancient Greeks could tell the exact time of the year, moon phases if it was time for plowing or planting, and the like, when the next Olympic games are to be held and thus when wars will cease, or even foresee solar and solar eclipses!

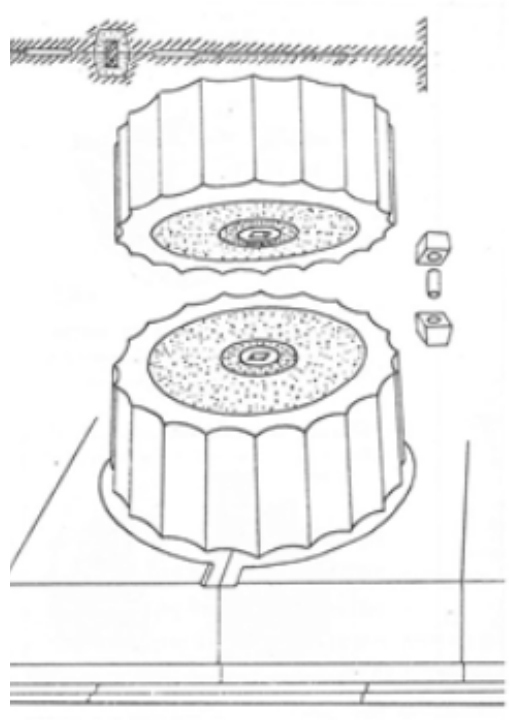
Ancient history and Archeology: How were those huge marble columns made and carried?

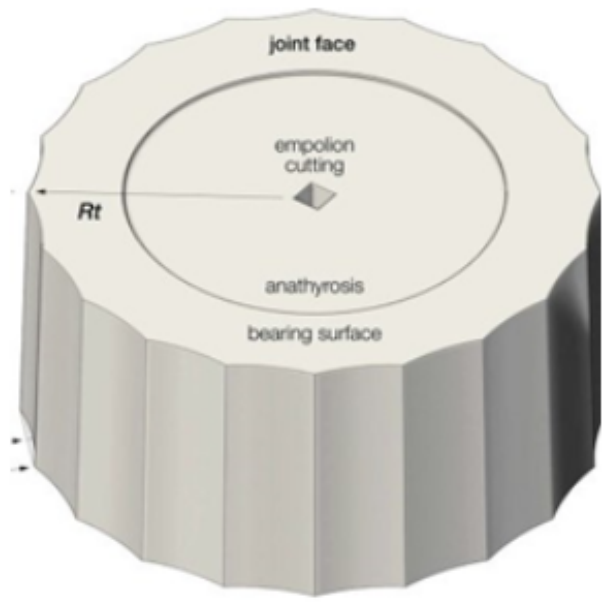
We expect that almost any high school student, wherever she or he may live, will have heard of or seen ancient Greek temples or palaces. A famous example is the Parthenon, located on the Acropolis of Athens. All of these ancient Temples used huge marble pillars to support them. Most of these pillars were designed following the Doric order (i.e. "style"), which (as anything Doric) was the simplest of all orders (the other two being the Ioanian and the Corinthian ones). Whatever the order, those massive marble columns were extremely heavy and therefore impossible to be carried in one piece. What ancient Greeks did, was use column pieces called drums that they used to hinge together by a lead rod at their center. In other words, they drilled holes in the exact center of each drum, and, after putting each one upon the other, thus forming the whole pillar, they poured molten lead inside them.

The above procedure could be explained either by taking the students to a place in Greece like the Acropolis of Athens, the Temple of Poseidon in Sounion, the Heraion of Samos, etc. or, quite effectively, easily and inexpensively, by utilizing a 3D model of Doric order columns (including their interior) like those below.

The above procedure could be explained either by taking the students to a place in Greece like the Acropolis of Athens, the Temple of Poseidon in Sounion, the Heraion of Samos, etc. or, quite effectively, easily, and inexpensively, by utilizing a 3D model of Doric order columns (including their interior) like those below.







Such models can be found and downloaded (at a fair cost or freely) from the repositories mentioned in the introduction, like TurboSquid, Sketchfab, and the like.

Using video games to teach history

We all know how appealing modern games are to teenagers (and not only to them). So, it was not hard for several teachers to utilize 3D video games as teaching aids. After all, what can be more interactive than a game? So, for example, there are studies that claim that First-Person Shooters (FPS) like "Battlefield I" can help teach history[1]. Especially the game mentioned above (in fact, it is its very first version mentioned, while today's version name is 'Battlefield 2042') has been used while teaching about World War I. There are former students who claim that this game indeed helped them grasp many details about life and fights in the trenches or other aspects of World War I history. This kind of software user will not seem weird to anyone who has watched even a short demo of the game. And, of course, it's those 3D animations that make it so appealing or even addictive to any young player.

So, do you want to talk to your students about, say, the battle of Verdun? We suggest starting with them watching a demo like this (https://is.gd/FQQciX) before opening their books to the specific chapter. It's certain that their interest will have grown a lot after watching the above or, even better, playing the game.

Besides FPS, there is a huge variety of video games that can greatly improve the teaching of history or another curriculum. We'll just mention two more of them: Sid Meier's CivilizationEdu and Minecraft Education Edition.

[1](Krijn H.J. Boom, 2020)

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The former is a modified version of the Civilization V game (another edition of the famous games series created by Sid Meir), which is designed especially for the classroom; while the second is also an adaptation of the famous Minecraft game and 3D modeling software (yes, Minecraft is not a mere game), tailored to be used as a tool for teaching various subjects. Both of them are free to use and offer a rich repertoire of 3D models, with Minecraft allowing (or better, “force”) the user to design her or his own ones. CivilizationEDU can be used as an educational tool to examine the interaction between military, technology, political, and socioeconomic issues, while Minecraft can be used for a plethora of curricula utilizing a repository of “hundreds of lessons created by educators around the world, for students of all ages.”

CivilizationEDU

Minecraft Educational

Remember though: Modern video games are very addictive

At this point, we really have to mention that although the utilization of 3D animated games in education is a very effective practice, one has to keep in mind that the side effects of excessive game-playing are quite harmful. Of course, this is neither the place nor the context to talk about video game addiction or other "computer-induced" psychological problems. Instead, it will suffice to quote an aphorism from ancient Greece: "Moderation in all things" ("metron Ariston" in Greek).

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Mobile applications. Use Mobile applications in Schools

CHAPTER III

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When first mentioning mobile applications, you may come to think of the big popular apps that you use in your everyday life. These apps could be for example, Facebook, Instagram, Wolt, Gmail or others. They are a part of our lives and we use them many times a day, without even thinking about them or how we use them. They have become more and more popular over the last 10 years and seem to be everywhere now and an essential part of our everyday lives. A Danish study from 2022 shows that 93% of the Danish population has a smartphone or tablet in their household. (Danmarks Statistik 2022)

This means that almost every person in Denmark has the possibility to use mobile applications on either their tablet or mobile phone. There is an increasing number of mobile devices in Danish households, and YouGov has conducted a study in 2019 that shows that Danish children get their first mobile phone at the average age of 8,5 years old, which is 2 years earlier than in 2015. (YouGov, 2019) This shows that children are getting younger and younger when they get their first mobile phones and that they are a part of the new digital age. They grow up with devices and learn how to use them from a very young age - perhaps some of them are even better at using digital devices than their parents?

3.1. How do we define mobile applications?

In order to be able to know how to use mobile applications and how they can be used in schools and educational institutions, we will, first of all, have to know what they are and how we define them. Therefore, here is the definition of what a mobile application is and its function;

A mobile application, most commonly referred to as an “app,” is a type of application software designed to run on a mobile device, such as a smartphone, tablet, or computer. Mobile applications frequently serve to provide users with similar services to those accessed on PCs. "Apps are generally small, individual software units with limited function." (Techopedia article, 2022)

1 Danmarks Statistik, 2022, Danmarks Statistik webpage, accessed 16/12-2022, https://www.dst.dk/da/Statistik/emner/oekonomi/forbrug/elektronik-i-hjemmet

2 Peter Elgaard, 2019, TV Syd webpage, accessed 14/12-2022, https://www.tvsyd.dk/bornenes-danmark-2019/josefine-fik-allerede-mobil-som-seks-arig-jeg-vidste-ikke-hvad-jeg-skulle

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Introduction to the requirements of an mobile application

To use a mobile application, the user has to have a smartphone or tablet that I connected to the internet. The user can download an app from the built-in "AppStore," where users can buy and download apps - either for free, for a smaller amount, or on a subscription. The application is a small piece of software that is downloaded directly onto your mobile phone or tablet. Most apps these days are very user-friendly. Many of them have an elaborate user guide when first downloading them that shows and tells the user how the app can be used, shows small shortcuts within the app, and other useful tips for better user-friendliness. This means that most people, no matter age, gender or mental capacity, are able to use apps without too much hassle.

3.2. Good practices in schools in Denmark

Digital learning is becoming a bigger and bigger part of our society and therefore also schools and different educational institutions. It is an inevitable part of society already. In Denmark, children are asked to bring computers or tablets to school on their first day of school in the 1st grade. However, the Danish law makes certain that primary schools and teachers can't demand that children, from grade 1 - 9, bring their own computers or tablets to school. This ensures equality among students and protects those students who may not be able to afford computers or tablets. Even with this law, most children in Denmark have a computer or tablet that they use for school work. If the parents or children cannot afford a computer, the school must provide a computer in order for the children to be able to participate in classroom work. Chromebooks have been very popular for primary school children in Denmark throughout the years. They are easy for children to use, durable, simple and not way too expensive.

All public schools in Denmark have their own policies for the use of digital devices during school time. The policies are often decided by the school's teachers, in collaboration with parents and the school board. Primary schools in Denmark feel that the use of digital devices and e-learning are a part of everyday life and that they have huge potential to teach students

4 IT works, 2022, IT works webpage, accessed 20/12-2022, https://it-works.dk/hvad-er-en-app/

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3.3. Why use mobile applications in schools?

There are many different perspectives to look into when talking about why we use or should use mobile applications in school, and whether or not we should use mobile applications in school and in a learning context. Many teachers have an opinion on this topic and some have rather strong opinions. Therefore it can be difficult to figure out the best way of doing things and reach an agreement. Listed below are some of the pros and cons that can be found on this topic:

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Benefits of using mobile applications in school

- Many applications allow students to practice at their own pace and let the students work at their own level
- Digital technologies can support a testing and iterative work process
- Digital technologies make new forms of collaboration possible
- New and better opportunities for teaching and learning (ex. online classes during covid-19 lockdown)

Disadvantages of using mobile applications in school

- Many pupils find it difficult to translate their digital experiences in their free time into a professional use of IT.
- Too many digital disruptions in education, such as digital communication (ex., from social media apps)
- No or little physical interaction with teachers or other students
- Restricted or no feedback from teachers

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3.4. How to connect virtual mobile with the curriculum and with primary and secondary schools

In Denmark, there is a political ambition that wants Danish children to be digital world champions and make them a part of the digitalization development going on in international society at the moment. There are various ways of connecting the two together, and there are no right and wrong ways since it is new to us all. It varies from school to school and teacher to teacher how they would prefer to use mobile apps in teaching. However, there have been numerous studies on good practices that can be taught to teachers who want to experiment with mobile apps in teaching.

3.5. Challenges of using apps in school

Over the past 10 years, the software and technology has developed very fast and therefore not all aspects have been thought through beforehand. We are only now understanding the consequences of using mobile phones and applications in schools. Lately, the big problem has been GDPR and how schools, teachers and parents can secure their children's personal data. The use of Chromebooks has been very popular in Danish schools over the last few years, and in summer 2022 a story broke about the safekeeping of students' data. One local municipality in Denmark has now prohibited the use of Chromebooks in primary schools, since there is not enough safety regarding the sharing of students' personal data to other countries and companies.

3.6. What type of apps should be used in school?

As mentioned earlier, there are many different mobile apps that can be used in schools. It also depends on whether the teacher wishes to use interactive apps where students can work autonomously or if they wish to use mobile apps where the students can interact with others or solve an assignment together as a team.

In Denmark, there is a huge digital learning platform, “Skoletube”, which is much used by students in primary school. It is a platform that has a bunch of different apps and tools to produce creative and professional content.

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With over 520.000 different educational apps available on the app store, it can be very tricky to find the best learning apps that match students interest and level. Here is a short list over some of the best educational apps that can be found in the app store.

Examples of mobile apps that can be used to solve assignments together:

- **Kahoot! is a game-based learning platform app that is recognized and used by teachers and students all over the world. Kahoot is user-made, multiple choice quizzes with a catchy melody. Kahoot aims to make learning fun! Kahoot is free to use. The quizzes are often solved together in teams in the class, or individually.**

Examples of mobile apps that can be solved by students alone:

- **Duolingo is one of the leading educational apps in the world, which makes it easier to learn different languages. Users can practice all aspects of languages from practicing grammar, pronunciation, vocabulary and listening skills. It is an app that users use individually and they can do it at their own pace. Duolingo is partially free, as some parts of the app require payment.**

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- **Quizlet is similar to Kahoot! as they too make it easy for users to make their own quizzes. The main difference is that Quizlet allows users to play other users' quizzes. In addition, Quizlet lets users make personalized flashcards.**

- **BrainPop hosts over 1,000 short animated movies for students in grades K–12 (ages 5 to 18), together with quizzes and related materials, covering the subjects of science, social studies, English, math, engineering and technology, health, arts and music. BrainPop is not free for users, but requires a small amount annually.**

- **Khan Academy is a non-profit educational organization and its goal is creating a set of online tools that help educate students. The organization produces short lessons in the form of videos. Its website also includes supplementary practice exercises and materials for educators. It has produced over 8,000 video lessons teaching a wide spectrum of academic subjects, originally focusing on mathematics and sciences. All resources are available for free to users of the website and application.**

Examples of mobile apps for teacher/student communication:

- **Remind is a communication platform for better and easier communication between schools, teachers and parents. It is used as an intranet where general information is exchanged about everyday life in school.**

- **Google Classroom is a suite of online tools that allows teachers to set assignments, have work submitted by students, to mark, and to return graded papers. It was created as a way to eliminate paper in classes and to make digital learning possible. It was initially planned to only be used on Chromebooks, but can now be assessed by all computers.**

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- **Padlet hosts a real-time collaborative web platform in which users can upload, organize, and share content to virtual bulletin boards called "padlets". It is free to use, although some Padlets may get deleted after a certain amount of time.**

Of course, this list is not extensive but mentions some of the most popular and well-known apps for students.

We can conclude that there is a lot of potential in the use of mobile apps in primary schools and that they can provide an alternative to classic classroom teaching. However, there are some concerns in the use of mobile apps, such as, lack of personal interaction, safekeeping of personal data and disturbance and distraction.

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CHAPTER IV

Principles of gamification. GBL and how to use them at school

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4.1. Introduction of gamification/ motivation/ requirements

Gamification is the art of inserting game elements into non-game environments to increase user interaction. Integrating the right fun elements, such as leaderboards and badges, into your existing system will increase the intrinsic motivation of your users and improve their results.

Gamification is the application of game design elements and game principles to non-game contexts. It can also be defined as a set of problem-solving activities and processes that use or apply properties of game elements. Gamification is also a way to inspire and motivate users to take action by setting measurable goals and rewards for them.

Games and game-like elements have been used for education, entertainment, and interaction for thousands of years. It has classic game elements like points, badges, and leaderboards.

Classroom gamification may include some or all of the following:

- Add rewards (such as badges) for completing certain tasks.
- Tracking points
- Enabling learners to create characters and avatars
- Integrating ability-based learning through 'levels' or 'platforms'
- Enabling students to 'fix' assignments and projects
- Give learners ultimate goals and options on how to get there
- Have an economic/money system in the classroom.

4.1.1 What is not gamification?

The methodological similarities and differences between 'mification' and 'games' (and 'gamification' and 'game-based learning') have also been analyzed so far. However, the terms "gamification" and "game" are still sometimes used interchangeably in many research articles. Although today many different methods are used throughout the learning process (e.g. flipped learning and gamification, mobile learning, infographics, etc.) The traditional" learning methodology is called "gamification". (or just games/GBL) is another common problem that misleads the concept of gamification. (Çeker, Eser; Özdaml, Fezile, 2017)

- Gamification is NOT:
- Playing a game in class
- Using a simulation to deliver a lesson.
- Only integrating technology

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- Just to have fun, it is a user engagement tool.
- Only a simulation, but the use of game elements in different contexts
- Restricted to a specific field only a competition between users
- Only points and leaderboards, are motivational tools
- On the need for heavy graphics to engage users
- Requiring many resources, but a lot of creativity and ideas.

4.1.2 Categories and types of gamification

Structural gamification

Structural gamification involves applying game elements to move the learner through content without modifying or altering it. The aim of this type of gamification is to motivate the learner to work with the content, keeping them engaged through rewards (Lee, Hammer, 2011).

An example of this type of gamification in E-learning is allowing learners to earn points for completing a task where the task had no gamification elements other than the offer of points.

There are some standard components to this type of gamification:

- Points: Learners earn points by completing specific tasks such as: watching videos and completing tasks.
- Badges: These are awarded to players when they complete specific goals.
- Achievements: Similar to badges, achievements are earned when students complete various assigned tasks and goals.
- Level: As the player advances through the content, the content continues to build on the concepts above.
- Leaderboards: Learners 'ranking' and their performance are displayed on leaderboards.
- Social Element: Students are encouraged to help each other when they see what their peers are accomplishing and struggling with. Social learning is a key component of success and can be enhanced through educational programs.

It is important to remember that structural gamification adds an external factor that turns an activity into a game but does not change the content. Story elements such as characters are part of the gamification, but the content remains the same.

Gamification of Content

Content gamification modifies the content itself to be more gamified. The content is not yet a game, but the content has added games and activities. The aim is to increase user participation by adding interactive elements.

An example of content gamification is starting a course with a fun challenge to keep the learner engaged, rather than starting immediately with a list of learning objectives. Another example is adding narrative elements as part of your content (Kapp, K. M., 2012).

4.1.3 Why Use Gamification in Education?

The theory of gamification in education states that students learn better when they are having fun. Not only that, but if there are goals, goals, and outcomes to achieve, of course, in a way that the learner finds enjoyable, they learn better.

Video games have the addictive properties of making kids (and adults) interesting and engrossed, so it's not surprising to see similar engagement results when applying these game-based elements to learning materials.

Gamification in learning involves using game-based elements such as scoring, peer competition, teamwork, and leaderboards to engage learners, help them absorb new information, and test their knowledge. While applicable to school subjects, it is also widely used in apps and self-study courses, proving that the impact of gamification does not end in adulthood. , and the companies that use it to train their employees have proven to be highly effective. Here's why gamification works.

- Games address basic needs (autonomy, courage, ability, etc.).
- Games can be social (for example, games can have places to display leaderboards and high scores so that players feel justified when they do well. Players can challenge their friends or invite other players).
- Gaming fosters ongoing engagement (gamification encourages users to keep playing to earn more points and rewards or to discover more information. which helps retain users).
- Giving the player (learner) control (feeling in charge of their own learning process).

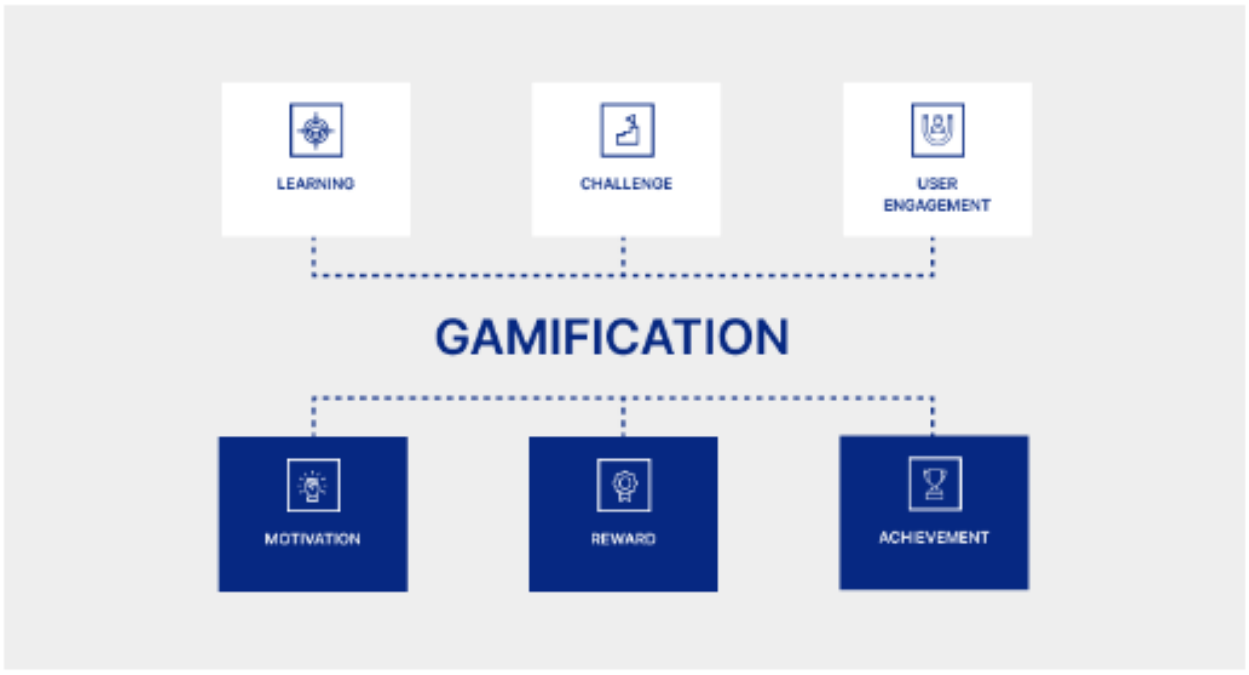
But what are the wider gameplay consequences?

Gaming works because it triggers real and powerful human emotions like happiness, intrigue, excitement, and achievement. All over the world, companies, institutions, and household brands are using gamification with great results.

Playing in the classroom has many proven benefits, including:

- Students feel responsible for their own learning.
- A relaxed environment about failure because students can easily try again.
- More fun in the classroom.
- Learning becomes visible with progress indicators.
- Students find intrinsic motivation to learn.
- Students can explore different identities with different avatars or characters.
- Students feel comfortable in a game-like environment. More comfortable, more active, and open to mistakes.
- Greater commitment and concentration of students.
- Ability to think outside the box.

But what are the wider gameplay consequences?



4.1.4 Effect of training

Playfulness in training can increase motivation and commitment. Game elements, such as immediate feedback and learning points for successfully completing challenges, significantly increase students' motivation to participate actively in game-based lessons.

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Short term effect

Gaming increases extrinsic motivation—the type of motivation driven by extrinsic rewards—but has not been shown to affect intrinsic motivation. This is an essential distinction because research has shown that extrinsic motivation only produces short-term effects at best, when students earn a badge or complete a challenge, their motivation to continue decreases.

The most convincing evidence of the effectiveness of gaming in terms of positive effects on engagement factors is as follows:

- learning time
- number of participants
- use of an e-learning platform
- activity
- other healthy behaviors.

To achieve motivation in the short term, one must achieve the so-called "Flow" state (Balci, Secaur, Morris, 2022).

Long-term effect

Regarding long-term effects although there is not much research and study on this topic, some long-term effects have been observed.

The social component of playful learning, where students play in groups, has many benefits for brain function. Social and intellectual engagement activates brain neurotransmission, brain plasticity, and connection formation and mitigates brain inflammation and the harmful effects of oxidative stress on the brain. The beneficial effects of social interaction have been interestingly highlighted for delaying dementia in the elderly.

Gaming changes the brain's reward and pleasure center and improves learning. It has been shown that games, where a person wins or receives positive feedback, can activate the brain's pleasure circuits, triggering the release of the neurotransmitter dopamine. It has been argued that educational games have the same effect as thinking about their elements in overcoming challenges or successfully achieving a goal. This enjoyment during playful education thus translates into a lasting affinity for solving complex problems in an academic subject or otherwise.

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In addition, the impact of games on the entertainment center has a significant impact on the learning itself. Indeed, reward-related signals have been reported to promote the storage of new information in long-term memory through dopaminergic modulation of the midbrain, which activates the hippocampus, which is mainly involved in learning and memory. Dopamine is also involved in regulating neuronal plasticity in the hippocampus, a vital brain phenomenon underlying the acquisition of new knowledge and skills. In addition, hippocampal memory has been reported to improve after playing video games in adults due to the stimulation of brain circuits.

4.2. What is game-based learning?

Game-based learning (GBL) integrates the characteristics and principles of games into learning activities. In GBL, learning activities promote students' engagement and motivation to learn. Components of game-based learning include point systems, badges, leaderboards, discussion boards, quizzes, and classroom feedback systems. Points can be accompanied by academic rewards, such as having an extra week to turn in an assignment once a certain point threshold is reached. Badges can be awarded if students reach a certain level of success, while classroom response systems, such as Kahoot or Top Hat, encourage participation through points.

Game-based learning is also an active learning technique in which games are used to enhance students' learning. Learning comes from play and encourages critical thinking and problem-solving skills. Game-based learning can be carried out with digital or non-digital games and include simulations that allow students to experience learning first-hand.

4.2.1. The elements of games

There are a large number of tools related to game components, as this is where there is the greatest similarity between them.

On the one hand, there are platforms that offer us a complete space to create our classroom with its avatars and skills, set challenges, and award badges.

- Chorewars (Published by Davis in 2006), for example, consist of gamifying tasks. To do this, it uses a series of avatars with different skills. Learners must improve through the activities performed. The tasks can be created by oneself, award the experience points (XP) that one considers appropriate, improve the skills that one considers appropriate according to the task to be carried out, and the possibilities of finding collectibles along the way. In addition, you can obtain objects, defeat the final monsters to get treasures, etc. It is a complete tool. The problem is that it is in English, which can be an obstacle for both the teacher and the students. http://www.chorewars.com/

- Edmodo (Published by Edmodo in 2013) is a similar example, the difference is a more formal environment and no storytelling, but they are making great strides in gamifying it. You can create a classroom, plan activities, upload content, and award badges. It is quite comprehensive.
- Toovary (Published by Advance Educational Entertainment in 2011) is a very interesting game designed specifically for gamification. Create a character, improve it through the acquisition of points, create challenges, etc.

4.2.2. Types of games

Video games for learning: serious games

In the field of game-based learning, there are educational video games known as serious games. This specific learning segment seeks to teach students specific subjects such as languages or to train professionals such as policemen, pilots, firemen, or health workers, among others. Educational video games are a booming market and are expected to be worth $17 billion in 2023, 485% more than in 2018, according to forecasts published by the Statista portal. Let's take a look at some of these products:

- Dragon Box is an introduction to geometry for young children.
- Extreme Event prepares students to cope with natural disasters and encourages teamwork.
- Pacific provides training in leadership and team management.
- Spore is useful for teaching biology, specifically the evolution of living things.
- Duolingo helps in learning languages such as English, French and German.
- Blood Typing, developed by the Swedish Academy, teaches about blood types and transfusions.

The benefits of video games

The impact of video games on society has been the subject of numerous studies. For example, in 2014, Andrew Przybylski, a psychologist at the Oxford University Internet Institute, published a study in the journal Paediatrics where he established how much time children should spend playing video games. He concluded that those who played for less than an hour were more emotionally stable, while those who played for around three hours a day developed social problems. So, when it comes to video games, moderation is the key because, in addition to improving learning ability, there are other benefits. Let's look at some of them:

- They speed up response times.
- Researchers at the University of Rochester have found that they improve problem-solving skills by posing problems that must be solved in a given time.
- They encourage teamwork
- According to the California-based Institute for the Future (IFTF), multiplayer games enhance teamwork in problem-solving.
- They stimulate creativity, concentration, and visual memory.
- The University of California has found that they stimulate these aspects by setting goals that require concentration, imagination, and remembering details to achieve.
- Improve strategy and leadership
- Video games put players in charge, honing their skills in resolving disputes, interacting with other players, and making decisions, according to the University of Pittsburgh.
- They teach languages
- The University of Helsinki found that they are useful for learning other languages through on-screen instructions, chats to communicate with other players, or storytelling.
- Critical thinking
- The technological institute of Monterrey published an article highlighting the ethical, philosophical, and social basis of these games and their ability to make players reflect and improve their critical thinking.

APPs

Educational apps facilitate children's understanding. Books are often tiring and boring for children but replacing them with colorful pages and moving animations can make learning fun to the core.

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Neuroeducation and Board Games

Neuroeducation presents a new model for the current educational system in justice, which shifts the burden of its curriculum to the creation of competent and competitive future professionals. . The current system excludes a large portion of the population and causes high rates of diarrhea and dropouts, he said. It is much more essential to use it, learn how to work with the resources available, and generate and produce new knowledge. Most teachers recognize that this must be the goal and that curriculum content and teaching methods must change significantly.

It wasn't until neuroeducation brought about a fundamental change in educational goals that we learned that educational administration turned out to be a slow machine. As a result, individual and collective initiatives have emerged from teachers, schools, and related groups working to change the knowledge base. These initiatives integrate the contributions of educational neuroscience, connected to current technology and supported by the mind, brain, and educational movement. One example is the work of David Sousa (2014). He emphasizes the importance of providing new experiences that promote neural activation, the need to maintain focus, and the importance of positive feedback that promotes effective learning, even if it occurs quickly. doing. Straight lines (shortest paths), rewards, and the desire for excellence are factors that preoccupy the brain as they enable neural activation and facilitate learning situations. It allows the amygdala, part of the limbic system that activates the release of dopamine, to enter when something suits us when it piques our curiosity and excites us. Dopamine is a neurotransmitter that enhances the performance of the prefrontal cortex and enhances attentional processes that enable learning.

This is the kind of "positive" experience that the brain likes to repeat over and over in a constant search for satisfying experiences. He is the only one who can learn what he loves, and only he can learn through emotion and joy (Mora, 2013). In other words, only emotions and joy allowing us to learn. Immediate feedback and rewards can also help you maintain the attention you need.

Play is where you can find all the elements proposed by neuropedagogy. No other activity offers us the challenge, the desire for excellence, the immediate feedback, the rewards, and most importantly, the excitement.

Attitudes and Basic Skills Developed Through Games establish effective educational systems that enable social, cognitive, and emotional connections.

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Language Skills

Language is essential for relating, communicating, and expressing ourselves with others. As a tool, it allows us to structure our thoughts and make sense of reality. Thus, our ability to see allows us to reason, solve problems, and engage with content that has a cultural component. Its development facilitates associative connections between different concepts, one of the most critical aspects of brain development.

Although this ability is primarily linguistically related, it is also related to the ability to interpret and extract information from graphs and tables and, thus, to the ability to understand and analyze both verbal and numerical information.

Board games are one of the group activities that best encourage intense communication and interaction. Exchanges, agreements, and negotiations require many actions. Language thus becomes essential for achieving game goals, activating auditory processes, and acquiring active and meaningful speaking skills.

One of the pillars of primary education is the acquisition of sufficient language skills to understand the meaning of texts. In this sense, the development of language domains is implicit in any board game. Each of the games presented here contributes to the acquisition of reading comprehension, as they all require an understanding of more or less complex rules to start playing. Additionally, a metagame is inherent in the game itself. It allows you to indirectly influence and perform the main tasks of negotiating, managing, creating combos, building relationships, and knowing how to "eat your opponent's ears."

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Verbal Skills Development - Board Games:

Verbalia There is countless verbal skills development games on the national and international markets. Offering 50 modalities of play, helping to acquire grammatical concepts, promoting vocabulary enrichment, and assisting in phonemic and syllable processes, its versatility

Set makes it an ideal game for stimulating visual perception. , helps develop the process of visual identification. Note the improvement. You can create sequences and assign them to different categories and sequences.

Beetle Salad, Beetle Soup, Beetle Soup. In addition to vocabulary searching, it is a simple game that also tests responsiveness, so it is particularly suitable for developing semantic fluency.

The Forbidden Desert or Forbidden Island is a cooperative game with strong narrative power that fosters dialogue and consensus in decision-making and planning and inspires intense dialectical action.

Rabbit and Turtle offer a deeper understanding of the fable playfully.

King of Tokyo aims to stimulate reading comprehension and text analysis with many action cards.

Fauna and Soil encourage descriptive reading practice and the development of associations that enable the acquisition of meaningful language.

Secret Codes, An innovative resource, allows you to associate different words creatively.

Blurble, a verbal expression game that encourages language with family and friends.

When I Dream: A game where you identify dream images and stories when you dream. The dreamer must be able to recognize the images on each card while blindfolded and must act to help or hinder the dreamer from identifying the images. We also encourage using synonyms and antonyms to help or hinder the dreamer or to use simple words that associate (or disassociate) the dreamer with the image within the image. increase.

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Time's Up Family **is a party by teams in which one of the players will give clues to their teammates to get the highest number of cards in 30 seconds. The game consists of 3 rounds: in the first round, you have to describe the object written on the card without being able to say the word or words derived from it. In the second round, you can only say one word, which involves much abstraction. And in the last round, you will mime.**

Concept **is a game where we have to make the other players guess a concept (chosen from cards) through the images printed on the board (without being able to speak). The images involve grammatical categories such as "big/small", shape, smell/nose/smell, up/down, etc. In this game, imagination is very important, as is the way we convey our ideas to the other players.**

QWERTY! **is a fast and fun game that stimulates lexical retrieval and vocabulary learning correctly. Each player takes a random number of tiles (from 3 to 5, depending on the number of players) and places them on the board, leaving them on the white side. Without touching them, all the players simultaneously look for words and say them without repeating them (only one per person). Scores are given according to whether or not letters have been repeated or if they are special letters. The used letters are discarded, and the others are returned to the bag. When there are no more tokens for everyone in the bag, the game ends, and the winner is the one with the most points.**

Black Stories **is the classic detective game where we are given a situation or a final scene, and we have to find out by asking the narrator what has happened. The answers must always be yes/no/irrelevant. There are no scores, and the game ends when we solve what happened—imagination and deduction in a simple card game. There is a White, Purple, Golden, etc. version, which changes the game's theme.**

Dixit **is a narrative and multi-thematic game that requires us to be creative and imaginative. It comprises a deck of illustrated cards with different, very dreamlike, and original situations. In each turn, one of the players will be the narrator, who must transmit an idea to the other players through a word, a phrase, or a song. He or she will then lay the card that represents that idea face down. The rest of the players will also lay down one of their cards that they think best suggests the idea given by the narrator. The players will try to guess which of all the cards is the storyteller's card and try to confuse their opponents with their own. Using a point system, their meeples will move up the scoreboard until they reach the finish line.**

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Story Cubes, small boxes with only nine dice with picture faces. Depending on what comes up after the roll, you have to generate a story. In addition to cognitive skills, it favors hand-eye coordination, visual perception, selective attention, concentration, working memory, planning, cognitive flexibility, etc. In addition, the story can be written down, so we also work on written communication and language skills. There are lots of boxes with different themes, which allows us to play them individually or by mixing the dice. Younger children can roll fewer dice to create their own story, which will gradually help them to learn the mechanics.

Quest Stories is a new narrative card game where players compete to collect the most coins by making up "tavern" stories. The tavern owner poses a problem (card), and each player, with their chosen group of heroes (all with major flaws, such as a giant with a fear of heights), tries to convince the tavern owner to hire their group of heroes. The others represent different recruiters who will try to convince the innkeeper to hire their group of adventurers, which rotates among the players.

Numerical competence

This is the ability to reason with numbers and use them in an organized, agile, and appropriate way.

It is related to the handling of basic mathematical concepts, arithmetical reasoning, and the ability to solve situations that require students to use numbers in their different manifestations.

The best way to consolidate concepts is to practice manipulative activities on a regular basis, relating them to topics and contexts related to the pupils; again, for this reason, board games are one of the most powerful tools for promoting this skill, as they allow the concepts acquired to be applied in a meaningful way, making pupils the protagonists and an active part of their learning.

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Mathematical competence development - Board games:

The little pig's gang, the turtle's race, and the hedgehogs on the run, helping the youngest children to understand and handle numbers in the numerical reading and writing and counting systems, consolidating the sequential processes from smallest to largest, and in the introduction to the symbols + and -, thus facilitating the real understanding of numbers.

Coloretto provides strategies for approximate and mental calculation, as well as seriation and planning related to logical reasoning.

Machi Koro City, Dominion and Sushi go! are closely related to planning skills, mental calculation, and the consolidation of numerical operations. They also favor the development of working memory, which is essential for good mathematical competence.

Movement is a game that consolidates perception, orientation, and spatial representations and enables the mental calculation of operations related to processing speed.

Fila Filo, in addition to favoring counting and sequencing, allows the internalization of complex spatial notions to develop through three-dimensional space.

Terra y Fauna, through the use of units of measurement (kg and gr, m, cm) and maps, allows strategies of approximation and estimation of measurements, taking into account an intuitive component and developing inductive reasoning.

Solitaire Logic Games would be more a category of Brain Games in which the same procedure is usually followed. We start from a given initial situation. Then, we have to try, think and reason what our actions should be to achieve the final result that has been requested. They are usually abstract games with one or several ingenuity solutions to the enigma presented, which is variable. Some examples are Battle of Geniuses, IQ Puzzle, Dr. Brain, etc.

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Spatial competence and logical reasoning

Spatial competence is the ability to mentally represent shapes, dimensions, coordinates, maps, proportions, etc. It makes it possible to imagine the rotation of objects in space, thus developing a three-dimensional perspective. It favours the sense of orientation, the interpretation of maps or the ability to situate objects adequately within a delimited space.

Logical reasoning, on the other hand, allows us to establish causal connections, solve problems and draw conclusions, and is therefore involved in many mental functions.

Both are related to the visual perceptual ability to construct visual representations and think with images and are very direct to the acquisition of reading, writing and mathematical skills.

Spatial competence and reasoning skills development - Board games

Cacao, **a resource management game with reasoning skills, whose design stimulates graphic interpretation and raises awareness of visual perception processes, thus facilitating the development of the spatial area.**

Carcassonne and Carcassonne Junior **allow players to develop their sense of orientation and directionality by constructing roads or cities, generating a map on which we will place our meeples (according to placement rules) to win points by majorities.**

Moving! **will introduce players intuitively to the world of volumes, as they will have to take into account the dimension and volumetric value of the strips to calculate the space they will occupy.**

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The Magic Labyrinth or Ricochet robots combine two areas not usually worked on: spatial orientation and working memory. Thus, it is essential to maintain active attention, which will favor optimal performance in attentional processes. In the second game, mental representation techniques will also be used to calculate distances and displacements. This way of working on orientation favors the consolidation of basic pre-writing processes in the youngest children.

Calisto and Ubongo **are games in which the sense, direction, or orientation of the pieces will complete their resolution; they promote processes of interpretation and compression of the spatial area, thus facilitating orientation and hand-eye coordination.**

The pieces are polyominoes, a particular case of polyforms well known for being commonly used in the game Tetrix.

Uluru **is a game of logic and reasoning in which we try to complete the patterns given on cards with our birds on an idyllic island, which is not always easy.**

Dimension**, similar in essence to the previous one but this time in 3D, with colored marbles. It is a three-dimensional puzzle formed from the starting conditions in each round.**

Kulami **is a marble game for two people, with most mechanics on a changing map of modules. It has a conditional move that forces the opponent to move in certain places determined by the horizontal and vertical of the last piece moved by the player in turn.**

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Attention and memory

Attention is a perceptual focusing process that allows us to direct our activity toward a specific stimulus and control it. A prerequisite for any learning process, it is a complex process whose stimulation cannot be separated from many other brain functions since other processes, such as memory, orientation, or executive functioning, are interdependent on it, so its stimulation will favor an improvement in the cognitive efficiency of many other mental functions.

Memory "is a neurocognitive function that makes it possible to record, encode, consolidate, retain, store, retrieve and recall previously stored information. While learning is the ability to acquire new information, memory is the ability to retain learned information" (J.A. Portellano, 2005).

The interdependence between attention and memory is evident: to be able to register information, attention processes are required; subsequently, there is a process of storing the information and, finally, a process of retrieval. All of this requires cognitive strategies in which, in addition to interpreting the information received, an analysis, categorization, association, and relation with other knowledge already acquired is carried out.

The effectiveness of attention and memory training is mainly achieved in an ecological context, i.e., by carrying out activities directly related to the pupils' natural environment, meaningful activities of great interest to them. The board game allows the child to get closer to this environment, as the themes are related to his or her interest. They are not related to an attention and memory training program but are presented as a playful challenge, which, as we have explained above, triggers various neuronal activation processes.

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Every activity involves an attentional process; if we add to this that regular practice incorporates knowledge of the game's theme, we can easily conclude that no game does not exercise both functions. Sometimes the theme may be the most appealing, sometimes the mechanics, sometimes the interaction, etc. The French call board games "Jeux de societé" because, although there are games to play alone, the vast majority seek a joint gaming experience that makes us remember not only the game but the final play experience and enjoyment. Therefore, a great game may disappoint us if the play experience is not rewarding because the people who played it did not contribute to making it rewarding.

Attention and memory development - Board games

Terra and Fauna are two games that activate associative processes, linking new information with previously acquired knowledge, a strategy that improves memory. ¡1, 2, 3! Now you see me facilitates the acquisition of repetition, grouping, classification, and image memory strategies.

Cocoricó, cocorocó, cocorocó! It is a good idea to start with the youngest children in the attention and memory processes. It uses a similar strategy to that of "memory."

Spooky stairs is an ideal resource for basic processes in these areas.

Ghost bombing enables the development of sustained attention.

The magic maze is an original resource as it combines spatially oriented attention and memory, which is unusual. The aim is to remember a path free of obstacles to lead our magician without dropping his magnetized ball.

Memoarrr is a card game with "Memory" mechanics in which everyone must rely on their memory and their buccaneer's luck to try to escape from the island. This game has several editions with different themes depending on the players' tastes.

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Types of board games

- ***Abstract games***

Board games that have no theme, or the one that is offered is so disconnected from the actual experience of playing that it might as well not be there (in gaming jargon this is known as having the "theme stuck". Checkers and Go are the purest examples of abstraction, while chess - with its set of named pieces and its suggestion of historical warfare - is relatively thematic by the standards of the category.
Examples: Checkers, Chess, Go, Tak, Shobu, Hive, Santorini, Kulami, Kamisado, Noctiluca, Patchwork, Blue (and its sequels), Calico, etc.

- ***Area control***

Board games with some kind of map or board that defines a space that players compete to dominate, usually by adding their own pieces to regions or areas or by eliminating opponents' pieces. Sometimes control can come through denying access to areas rather than taking them yourself - Scrabble is arguably an example of the genre!
Examples: Small World, Risk, Nanty Narking, Blood Rage, El Grande, Samurai, Underdark Tyrants, etc.

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- *Campaign/legacy (Legacy games)*

Campaign board games are defined by individual plays that follow a series of connected scenarios, where the actions and outcome of one scenario often affect the next. Legacy board games are a specific type of campaign game where your choices and actions cause you to make permanent (often physical) changes to the game and its components, such as applying stickers to the board or breaking cards, often providing a unique experience.
Examples: Gloomhaven, Pandemic Legacy, Charterstone, Betrayal Legacy, Clank Legacy, etc.

- *Deckbuilding*

Each player starts with their own identical pack of cards, but modifies it during the game, adding more powerful cards to the deck and removing less powerful cards. Not to be confused with LCGs (Living Card Game) or collectible card games, which are detailed in the next category.
Deck building usually starts with a basic pack of cards (identical or very similar - balanced- among players, in which by the mechanics of the game we will improve it with new more powerful cards that usually come out in a common market that can be accessed with certain resources. In this case, creating and customising the deck is part of the core game experience.
There is a variant of this mechanic called bagbuilding, where you draw pieces from one or more blind bags and then manage those pieces according to their characteristics or powers, just like in board games such as Draftosaurus.
Examples: Dominion, Star Realms, Undaunted: Normandy, Harry Potter: The Battle of Hogwarts, Clank!, El Dorado, Thunderstone , Legendary Saga (Legendary Marvel, Alien, Predator, X-Files, etc.).

- *Trading Card Games and "Living Card Games"*

Both are a type of board game in which players use different packs of cards to play with, constructed before the game from a large set of options, according to specific rules. There are two main distribution models: trading card games sell booster packs with a random set of cards in each one in which we do not know what will come out, while Living Card Games provide a fixed set of cards in each expansion that the user can know in advance in order to add to the base game and enhance the game experience by adding new characters, quests, rules, etc.

- ***Living Card Game***

is a type of card game that eliminates the randomness of the packs purchased, allowing you to check before you buy which cards will be included in each pack. This type of game includes a basic set to play with and then more expansions are released on a regular basis. LCGs apply only to games produced by the company Fantasy Flight Games, which has trademarked the term.
Examples are: Magic: The Gathering, Android: Netrunner, Marvel Champions, Arkham Horror: The Card Game, The Lord of the Rings: The Card Game, etc.

- ***Dexterity***

Board games that involve physical dexterity, either using the whole body as in Twister or just the fingers to move things, such as removing blocks in Jenga. This can include moving discs or other objects with the fingers, as in Flick 'em Up, balancing things in games like Beasts of Balance or even throwing objects, like Dungeon Fighter.
Examples: Cube Quest, Catacombs, Flip Ships, Flick 'em Up, Crokinole, Beasts of Balance, Tuki, Junkart, Carrom, etc.

- ***Draff or Draffing***

Draffing is a mechanic in which players are presented with a set of options (usually cards, but sometimes dice or tiles) from which they must choose one, leaving the rest for the next player to choose from. The selection can be made from a shared central pool of options, or from a hand of cards that are passed between players. This can be a small part of the game, such as selecting an ability to use during a round, or the entire decision space of a game.
Examples: 7 Wonders, Sushi Go!, Villagers, Draftosaurus, etc.

- ***Engine Builder***

In the course of an engine-building board game, you will build an "engine": something that takes your initial resources and/or actions and converts them into more resources, which in turn become even more resources, which - at some point down the line - will usually become a form of victory points.
Examples: Res Arcana, Century: Spice Road, Race for the Galaxy, Galaxy Trucker, etc.

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- ***Dungeon Crawler***

Players take on the role of characters making their way through a location, often represented by a grid map or a page in a book, defeating enemies controlled by another player, a companion application or the game system itself.
They are often accompanied by a multitude of miniatures that are the ones that move around the squares of the board. The theme can be extrapolated from the dungeons themselves, such as space themes, horror, pirates, etc. They are usually games where the dice play an essential role in passing the different challenges and therefore, the chance is a particularly important element in the game.
They are sometimes called "Ameritrash" by those who do not like the element of high luck. These types of games are usually expensive because of the amount of plastic components they have, although there is not always a good game that supports such a price.
Examples are: Descent: Legends of Darkness, Gloomhaven, Mansions of Madness, Star Wars: Imperial Assault, Mice and Mystics, Lord of the Rings: Journeys through Middle-earth, Mémesis, etc.

- ***Eurogame***

Often abbreviated as "Euros", these are board games focused on strategy, prioritising mechanics over aesthetics or even theme. They tend to be competitive and interaction between players is through passive competition rather than aggressive conflict. They are so named because many of the earliest games of this style were developed in Europe, especially Germany, in contrast to the more thematic but chance-based "American-style" games of the time.
Critics of this style of games call them "soulless games" or "cube-moving games", because of the simplicity of the components and the functional but spartan boards.
It is increasingly common to find hybrids between the two categories "Ameritrash and Eurogames", known as "Eurotrash" where the mechanics take precedence, but with an aesthetic design and quality components that fit a predefined and concrete theme beforehand. Ex: Wingspan.
Examples: Agricola, Hansa Teutonica, Peaky Blinders, Settlers of Catan, Power Grid, Terraforming Mars, Concordia, etc.

- ***Push-your-luck (Push-your-luck)***

This is a mechanic tailor-made for the bravest of the brave, as board games with this system get our adrenaline pumping by testing our luck and pushing our luck to the limit in order to win. You will have to risk more or less depending on your position, which sometimes works out well and sometimes not so well.
Sometimes it is also called Press-Your-Luck.
Examples: Quedlinburg Healers, Port Royal, Deep Sea Adventure, Strike, Turtle Island, Diamant, etc.

- ***Roll & Move (Roll & Move)***

Board games in which you roll one or more dice and move as many spaces, usually on a looping track of spaces, or a path with a start and an end. Often, landing on certain spaces will trigger specific actions or offer the player certain game options. Older games such as Goose or Parcheesi used these mechanics where players are prisoners of the outcome of their dice and make few decisions. Subsequently, these mechanics have been refined to allow players to choose multiple alternatives or by using elements of chance control, such as die roll modifiers, etc.
Examples: Monopoly, The Game of Life, Snakes and Ladders, Formula D, etc.

- ***Roll & Write***

Roll some dice and decide how to use the result, writing it down on a personal score sheet. Each decision influences your choices for the rest of the game, so even in games where everyone uses the same dice, slightly different choices at the start can lead to very different end results. Some games change the name by replacing dice with something like cards for a "roll and write" (Welcome To...) or writing with something like miniature placement for a "roll and build" (Era: Medieval Age).
Examples: Yahtzee, Railroad Ink, Ganz Schon Clever, Corinth, Hadrian's Wall, Cartographers, Qwinto, etc.

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- ***Social deduction***

One or more players at the table have a secret or partial clue, and the rest have to try to figure it out or piece together the clues to unravel the mystery. Lies, bluffing and wild accusations are expected everywhere. Players are often assigned hidden roles that only they know about, and must achieve their own goals, usually by finding the weirdo, or hiding the fact that you are the weirdo yourself.
Some feature less interaction, but increase the level of deduction. They can be competitive or collaborative games, where in either case you have to deduce or solve the mystery from partial clues. This is the case of: Cryptid, In Search of Planet X, Amelia's Secret, etc.
Examples: Blood on the Clock Tower, A Werewolf Night Definitive Edition, The Resistance, The Resistance: Avalon, Uncomfortable Guests, Secret Hitler, etc.

- ***Storytelling***

Board games focused on narrative and description, directed or created entirely by the players. This can be an overarching story that lasts for the entire game - or over the course of a multi-session campaign - read from prescribed passages, or a sequence of vignettes in which players have to invent and describe something triggered by a single card.
Examples: The King's Dilemma, Tales of a Thousand and One Nights, This War of Mine, For the Queen, etc.
There are board games with similar experiences to role-playing where the story plays a major role. Sometimes they require a master and sometimes they are replaced by an App. Some examples are: Dungeoneer, Talisman, Pathfinder, Thunderstone, Massive Darkness, etc.

- ***Worker placement***

Board games in which you choose actions from spaces on the board by assigning your group of "workers" - often thematically real workers in your service - to your group. They are usually Eurogames, with interaction between players, as actions performed by one player often cannot be performed by another or have a cost to them.
Examples: Charterstone, Agricola, Cavern, Lords of Waterdeep, etc.

- ***Party games***

As the name suggests, these games are designed to have fun in the company of friends. They are games with simple rules that can be learnt in a moment, where laughter is the main thing, and where the mechanics are not very important. They usually last 5-15 minutes, and are usually a good incentive to play with children or as a preparation for a more intense play session. They can be card games, plasticine games, games with plastic components, skill games, bluffing games... in fact, they can involve other mechanics, but with that component of fun and development in a very short time.

- ***Pick-up and Deliver***

This mechanic generally requires participants to pick up an item at one location on the game board and take it to another location. The initial placement of the item can be predetermined or random. Typically, the action provides money, points or resources for further actions. In most cases, there is a game rule or other mechanic that determines where each item should go. In these games it is very common to find themes or settings of trade, resource management, Eurogames, territory occupation or civilisation evolution.
Examples include: Back to the Future, My Little Scythe: Castles in the Air, Clinic, Yukon Airways, Black Fleet, Firefly, Merchants & Marauders, etc.

- ***Escape Rooms (room escape games)***

This type of game recreates the experience of an Escape Room around a table. They are usually time-based games (usually 1 hour) to get out of the room, unravel the mystery, complete the mission, etc. They are mostly cooperative games, although some games feature individual objectives for the players themselves.
Examples are: Saga Unlock!, Saga Exit, Escape Room: the game, Escape the room, Saga Hidden Games Crime Scene, Escape Party, The Enchanted Forest, Countdown, etc.

- ***Wargames***

Players play armies against each other, represented by collections of miniatures or counters on a map, with a grid representing actual measured distances for movement. The opponent's figures must be eliminated or objectives reached to win, and combat is often dictated by dice rolls or card hand management.
They are usually very long games, with complex rules, and require players to be assiduous and committed for long periods of time (sometimes played over several sessions, leaving the game set up).
Examples are: Warhammer 40.000, Memoir '44, Risk, Axis & Allies, Battlelore, Tetrarchia, Commands & Colors (various editions), Conflict Of Heroes The Awakening Bear Third Edition, Churchill, Undaunted, Here I Stand, Twilight Imperium, Twilight Struggle The Cold War, For the people, Combat Commander, 2Gm tactics, etc.

4.3. How to connect it with the curriculum and with primary and secondary schools

As showed before Game base learning and Gamification are concept that can be applied in schools and is up to the teacher decide wich one is better to use based on his own experience in GBL or Gamification.

Using GBL is more immediate then gamification as there are a lot of resources already prepared and ready to use. The teacher only need to know the game mechanic and use based on the needs of the students.

Implementing gamification in classes can be a little more complicated as require more time for the preparation of it. The teacher can find free or paid resources online as “classdojo” or “myclass game” to be helped during the creation of gamification for his classes but will be up to him and his experience in gamification develop content based on the classes and age of the students.

CHAPTER V

Collaborative Tools and interactive resources (social media, video, image processing, youtube Channels)

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5.1. Introduction of Collaborative Tools and Interactive Resources

5.1.1. Collaborative Learning and Collaborative Tools

Collaborative learning is the educational approach of using groups to enhance learning by working together. Groups of two or more learners work together to solve problems, complete tasks, or learn new concepts. This approach actively engages learners to process and synthesize information and concepts, rather than using rote memorization of facts and figures. Learners work with each other on projects, where they must collaborate as a group to understand the concepts being presented to them. Through defending their positions, reframing ideas, listening to other viewpoints, and articulating their points, learners will gain a more complete understanding as a group than they could as individuals.

Collaborative vs. cooperative learning: What is the difference?

There is some confusion about what the difference is between these two types of learning.In fact, cooperative learning is a type of collaborative learning, which is why at first glance, the two might seem similar.The difference between cooperative learning and collaborative learning is that, in cooperative learning, participants are responsible for a specific section of their own learning and success, and also that of the group as a whole.They must use their knowledge and resources to make sure that all team members understand the concepts that they are learning. The roles and structure of cooperative learning are predefined, and are often likened to the cast and crew of a theatre production: the success of the show depends on all of the interconnected roles supporting each other, but there is a director overseeing the project closely. To think about collaborative learning in terms of roles within an organisation, in software development, a group of junior developers has a task to learn a new framework, then develop part of a program while using it. Each developer has their own part of the code to develop, but their work will only be successful if everybody learns and performs their part properly. Even though each person has a separate role in the work, the entire group has a stake in the success of others. In collaborative learning, individual participants must also take responsibility for their team learning and succeeding, but their roles, resources, and organisation is left up to them. There is no director to administer the rules of engagement, so the group itself must self-direct.

Well-known types of Collaborative Learning?

"Cooperative learning is an educational approach that promotes interaction among students and shared responsibility for academic achievement" [Stein, R. & Hurd, S. (2000). Using Student Teams in the Classroom. Bolton MA: Anker Publishing Company, Inc.: https://eric.ed.gov/?id=ED446603]

The following examples are among the most well-known types of collaborative learning:

- **Think-pair-share; is a low-stakes, low-effort strategy for active learning and abbreviated collaboration. Students must work independently, communicate their ideas to peers, consider peer responses, and share that discussion in a way that begins to synthesize an exchange. While it is unlikely that all pairs in a class will have the opportunity for the last step, calling on random pairs means that most should be prepared. Think-pair-share requires that students act instead of passively listening.**

o Give students a discussion prompt, question, short problem, or issue to consider.
o Individuals work briefly on a response.
o Peers report their responses to each other in pairs.
o Some (or all) pairs summarize their discussion for the large group.

Problem-based learning (or PBL); introduces a specific problem to students, usually in groups, over an extended period and requires that they understand the problem and begin to propose a response or solution. PBL begins to approximate the sort of work scholars do (think of the "problem" as a research question), as well as the way students may need to approach problems in their lives after higher education.

- **Guided Design, a type of PBL, leads students through steps as they work on a problem. So, for instance, groups might do preliminary research and report back simultaneously, identify stakeholders and report back simultaneously, propose compromises and report back simultaneously, etc. For more information about PBL, visit the University of Delaware's Problem-Based Learning Site at www.udel.edu/inst and come to talk to us at the Teaching and Learning Transformation Center.**

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- Case studies; provide students with sample problems from experience. So, for instance, students in microbiology might propose a response to a waterborne viral outbreak. Find more examples for the sciences and humanities at the National Center for Case Study Teaching in Science sciencecases.lib.buffalo.edu.

- Simulations; ask students to adopt roles as they perform the work of a problem-solving group. Students of government and politics, for example, might take on the roles of business owners, city council members, and neighborhood advocates in a zoning dispute.

- Peer teaching; is a very effective means for both the student-as-teacher and student-as-learner to learn new concepts. One example of peer teaching is tutoring, which means guiding the learning of a newer student. This can be as informal as a brief discussion in which a student explains a concept or clarifies a misunderstanding. Supplemental instruction is the extended guidance students receive over an entire course from a secondary source (e.g., a tutor). Presentations ask students to communicate course material to their peers effectively. This requires more than restating content or paraphrasing the day's readings.

- Small group; discussion offers students the chance to interact with peers, listen, and teach. Effective small group discussion is guided by clear directions and asks students to share a product (a summary of the discussion, a consensus view with a minority report, or even a critique of the discussion prompt).

- Peer editing; guides students as they review each others' drafts of written work. This foundation of the craft of academic writing serves to teach both editor (who must learn to read critically and communicate criticism) and the writer (who must learn to consume, evaluate, and incorporate feedback). When requiring peer editing, articulate clear expectations instead of simply asking students to read and evaluate writing (e.g., have them identify a thesis statement and assess the strength of the writer's evidence).

- The jigsaw strategy; breaks problems into small parts and assigns parts to groups who report back, contributing a piece of the puzzle's solution. For example, each student in a group might be assigned a distinct article to read on a shared topic or issue; each would present that article to the group to synthesize all articles.

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The Benefits of Collaborative Learning

There are many benefits of collaborative learning, both for the organization as a whole and the learners as individuals.

- The organizational benefits of collaborative learning

· Develops self-management and leadership skills

When individuals are tasked with working together to achieve a common goal, they are given the opportunity to develop high-level skills. While having to organize, assign, and teach, they are learning how to manage themselves and others while leading in a productive fashion.

· Increases employee skills and knowledge

When employees participate in collaborative learning, they develop a wide range of skills and knowledge. Not only will they strengthen their existing skills by having to teach others, but they will also learn new skills from other employees. This reduces the need for formal training while encouraging employees to upskill in known concepts and engage with new concepts continually.

· Improves relationships across teams and departments

When individuals have limited contact across teams, it is difficult to foster connections and teamwork. Collaborative learning across teams forces individuals to develop new connections and find ways to work together. This can be especially beneficial for organizations that depend on remote workers, as fostering strong connections among distant workers can be difficult.

· Improves knowledge acquisition and retention

Studies have shown that utilizing collaborative learning may lead to increased involvement and better retention of knowledge. The process of collaborative learning allows participants to achieve higher levels of thought, and the information is retained much longer than when learned in a non-collaborative setting.

· Improves employee retention and promotes workplace engagement

Employees given the opportunity to learn new skills tend to be more satisfied in their work and are less likely to seek other opportunities. Satisfied employees are more productive and will engage in their work, leading to increased efficiency and output.

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- **The individual benefits of collaborative learning**

· **Turns learning into a truly active process**

The learner must organize their thoughts, present a cohesive argument to demonstrate their point, defend that point to their peers, and convince others that their argument is correct. This active engagement means that the individual learns and retains more knowledge.

· **Promotes learning from others' viewpoints**

Learners benefit from hearing diverse viewpoints. Studies show that when people are exposed to diverse viewpoints, especially from people with varied backgrounds, they learn more.

· **Teaches how to think critically and quickly**

The learner must quickly synthesize responses and, if they find that their argument is lacking, adjust their ideas on the fly. Individuals learn how to think critically and quickly while intaking new information and adjusting their own viewpoint as new ideas are introduced.

· **Promotes listening to criticism and advice**

The learner will also listen to others talking through their ideas, offering their thoughts for or against their peers' arguments. This dynamic approach means that learners gain a full understanding of the topic, as they have to consider it from all angles.

· **Develops public speaking and active listening skills**

Individuals learn to speak well in front of an audience of their peers, listen actively, challenge ideas, and build a framework of ideas in conjunction with others. This increased social ease will help individuals both socially and at work.

- **Improves cooperation**

When given a specific goal, learners are more likely to engage in thoughtful discussion with each other, improving both their understanding of the subject and their esteem for each other.

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Collaborative Tools

A collaboration tool helps people to collaborate. The purpose of a collaboration tool is to support a group of two or more individuals to accomplish a common goal or objective. Collaboration tools can be of a non-technological nature, such as paper, flipcharts, post-it notes, or whiteboards. They can also include software tools and applications such as collaborative software.

Three aspects of collaboration: communication, coordination, and cooperation, can be used to categorize collaboration tools.

- **Communication**

Communication tools provide an exchange of information between individuals:

- **E-Mail**

The invention of email as a collaboration tool changed the way we used to communicate in the workplace. It is the easiest method to make contact within an organization and is well-established. Especially for organizing daily correspondence, email can reach various people with just one click.

Although email is still the most commonly used tool in communication collaboration, it is not very efficient on a big scale, and other forms of communication seem to take over. Besides its flexibility, it is not very good for group conversations as they grow too fast. There is no way to be sure that a person has the latest version of a document that has been sent to them, and it is impossible to always track via email what tasks need to be done and by which deadline. As Cisco states in their Cisco Blog about the "Future of Email," emails "will improve productivity by organizing your data for you" and try to bring more transparency in their work with email.

- **Voicemail**

Voicemail as a collaboration tool is increasingly integrated into services such as Google Voice. As pointed out in an IBM future scenario, the role of voicemail could be what email is for us today.

- **Instant messaging (IM)**

Through instant messaging, as a collaboration tool, we are able to reach people within an organization in real-time. In the future instant messaging is not a stand-alone software anymore but will be very well integrated into bigger solutions such as Unified Communication.

- **VoIP (voice over IP) / video call**

Voice over IP as a collaboration tool has quickly gained popularity among companies and is part of their communication portfolio. As a report from Eclipse Telecom is pointing out, VoIP is moving towards the state to totally replace our telephones in our offices and also integrate into existing collaboration service environments.

- **Coordination**

Coordination is defined as "the deliberate and orderly alignment or adjustment of partners' actions to achieve jointly determined goals." Collaboration tools supporting this are the ones that allow a person to set up group activities, schedules, and deliverables.

- **Online Calendars**

Online calendars are part of professional behavior at work and are fully integrated into other systems. As a research paper from the University of Bath explains, online calendars could, in the future, be much more closely linked to other data, such as social media, and have even a larger effect.

- **Time trackers**

Time trackers are especially used to measure the performance of employees. Its effect on productivity is discussed as being controversial.

- **Spreadsheets**

Spreadsheets are like emails, popular within the corporate environment and as a collaboration tool essential for financial analysis or modeling. Although very popular, several studies found that many spreadsheets contain inaccurate data and are, therefore, inefficient.

- **Cooperation**

Cooperation tools allow groups to have real-time discussions and to shape an idea or thought together. Trends in terms of collaboration target helping to maintain the "main idea" within big organizations and make connections visible. Also, the idea of bringing people who are not working in a company on a regular basis into the organization and making use of their knowledge.

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- **Video conferencing**

In most cases, video conferencing is part of the overall communication and collaboration strategy of organizations. Especially now that all services are cloud-based and, therefore, implementation costs have become more affordable. The long-term vision for video conferencing lies in the correct usage of computer processing power, data storage, or mobile bandwidth speeds to further decrease the obstacles to collaboration.

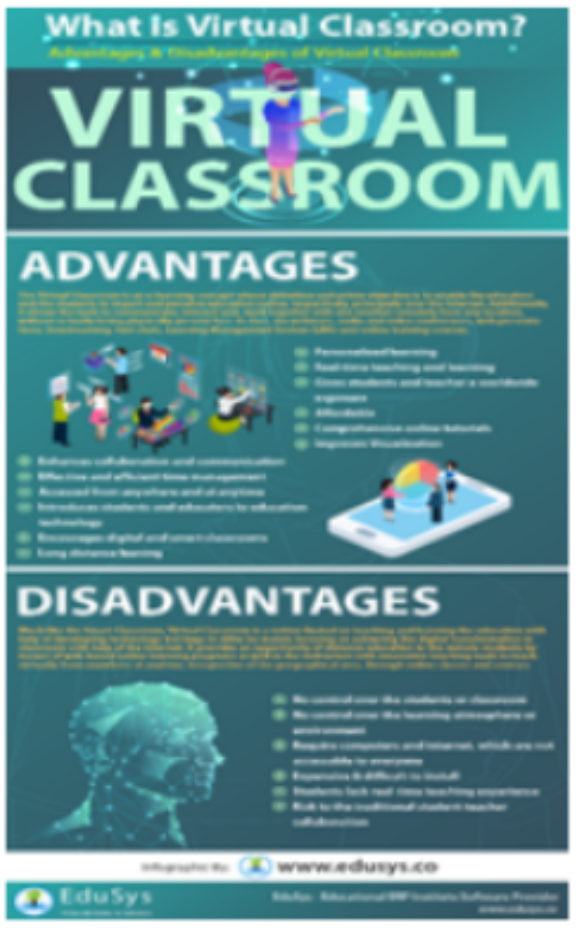
- **IM teleconferencing**

Bringing teams, meetings, or events as close as possible is what teleconferencing solutions want to do. Apart from business environments, Teleconferencing is currently used in various fields, such as telemedicine, where they contribute enormously to efficiency and productivity as distance and time are limited factors.

5.1.2. Interactive Resources

Creation of a Virtual Classroom

A virtual classroom is an online learning environment that allows for live interaction between the tutor and the learners as they participate in learning activities. It offers learners opportunities for flexibility, interaction, and collaboration, distinctly different from face-to-face learning environments.



Advantages of a virtual classroom

The virtual classroom can help with instructor organization. Areas for course documents, assignments, class notes, and other information can be readily categorized.

- Personalized learning: Students can learn in their own time and phase
- Long-distance learning
- Enhances collaboration and communication
- Real-time teaching and learning
- Effective and efficient time management
- Gives students and teachers a worldwide exposure
- Accessed to everyone equally from anywhere and at anytime
- Affordable
- Introduces students and educators to education technology
- Comprehensive online tutorials
- Encourages digital and smart classrooms
- Improves Visualization

5.1.3. Social Media, Video and Image processing, YouTube Channels

Social media can be an effective way to engage and educate learners. By using creativity and a little bit of caution, you can integrate social media into your virtual classroom in a way that provides learners with an exciting and robust educational experience.

In a study published in 2013, Babson and Pearson found that 41 percent of professors in online and face-to-face classes have used social media in their teaching. That's a 21% increase from the year before. In the following years, especially at the end of 2019, with the pandemic lockdown, social media and online learning have expanded dramatically, and this number will have risen accordingly.

Teachers, instructional designers, educational institutions, companies, and even organizations have started to rely heavily on the use of social media in formal learning to share practices, promote information and educational material, share opinions, views, and comments, embodying them in training programs and individual courses.

One of the best outcomes is that learning has become learner-centric and not teacher-centric, which is how it should have been all along.

In the Covid-19 Work-From-Home scenario, most educational institutes have adopted online education. This model is heavily dependent on e-learning tools, and there are a lot of tools available in the market. What is the best combination of e-learning tools, for example, for the following activities:

- ✔ 1. Learning Management (e.g., Moodle)
- ✔ 2. Lecture Delivery (Microsoft Teams, Google Meets, Zoom, etc.)
- ✔ 3. Video Editing and Compression
- ✔ 4. Video Hosting, Streaming, and Downloading
- ✔ 5. Assessments, Exams, etc.

How Social Media Can Be Used As Learning Platforms?

Let's see the most popular ones:

- YouTube: An excellent resource for e-learning. It's free and can be used to support a class, while viewers can also rate the video's content and quality, as well as comment. These videos can be part of a course, but instructors can also use them to broadcast entire tutorials or teasers to attract the audience they want.

- Facebook: The instructor can effortlessly create a closed or open group to share information, ideas, quizzes, questionnaires, materials, pictures, or even an entire page on a specific course or module. Students can freely discuss various course-related issues and questions they might have, post mutually interesting information, and generally, things they want to share.

- Twitter: In e-learning, it can be used as a backchannel to connect learning communities or smaller classrooms over a specific topic or event, share highlights, make statements, upload pictures, etc. All instructors must do is create an account and communicate its #hashtag to their students/followers.

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Google Plus: Google plus is an uprising star for social learning. Google plus communities have been used heavily as learning platforms, and one of the primary reasons is that learners and facilitators are getting less distracted versus Facebook and Twitter. In addition, Ronald L. raised an interesting issue “Students don’t like to use their social networks for their studies. They want to keep their private life, and faculty life separated”. Last but not least, I very much agree with Steve Rayson, who said: “The ability of G+ to host communities with video embeds, comments plus Google hangouts surely makes it the strongest social media platform for social learning.”

What programs can we use to assemble the movie?

Each creator of educational films should become familiar with the programs allowing for the proper preparation of the film material. There are many programs available that allow you to perform more and less complex operations on our movie. Below there is a list of sample programs that you can use.

- **Microsoft Movie Maker**

The basic program for processing visual materials. It allows you to create movies from photos, videos, and music. It includes simple functions such as combining different recordings, inserting background music, adding captions, selecting filters to change the appearance of the movie, and inserting transition effects — an excellent program to start with.

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- **Quick 5**

Program for Android. Simple to use and completely free. The program provides easy editing, allows you to use many styles, and adds music.

- **HitFilm Express**

A good choice for beginners. The program includes many options to facilitate and speed up editing. Moreover, it is intuitive and flexible.

- **Lightworks**

A program in which many Hollywood films have been edited in the paid version. The free version has all the major features. It is not an easy-to-use program - it takes time to learn.

5.2. Good practices /applications in school per each country

5.2.1. What is Glogster Edu?

Glogster is a Web 2.0 platform that allows users to create interactive online posters called glogs, by adding images, videos, audio and text. As a learner-centered tool, Glogster supports students' building of knowledge by allowing them to construct their own meaning of the content.

GLOGSTER EDU is a secure educational platform, especially created by Glogster for use by teachers and students to protect students from being exposed to inappropriate content and contact from outsiders. It provides a high level of privacy and security and gives teachers the ability to create, monitor and administer their students in a virtual classroom setting. Web: http://edu.glogster.com/

Teachers can create glogs for their students to use, can structure entire classes or even homework assignments by linking or embedding all the necessary resources to one page,the glog. GLOGSTER not only provides teachers with a tool to differentiate the curriculum but with its audio visual qualities appeals to visual-spatial learners and is especially effective for use with special needs and ESL students.

Students can make glogs for projects, develop creativity. Glogster gives students the opportunity to increase their digital literacy skills whilst demonstrating their knowledge and understanding in a fun, engaging and creative manner.

Students must be capable of designing and sharing digital information. It is recommended to integrate digital tools into classroom activities, emphasizing the teachers' responsibility to prepare students to use digital media effectively. The current generation of Internet technologies, Web 2.0 tools, facilitates interactive information sharing in collaborative digital environments. Their use in educational setting has increased dramatically in recent years due to the development of educational versions specifically designed for student and teacher use.

Important research indicates that web-based tools can support student´s learning, specifically the development of critical reading skills and the ability to evaluate online texts, and provide opportunities for students to write texts for authentic purposes (Handsfield, Dean, & Cielocha, 2009; Larson, 2010; Zawilinski, 2009).

5.2.2. How Glogster can be used in the classroom?

- to publish resources for groups and projects,
- to get struggling readers and writers to start producing
- to brainstorm writing for gifted writers
- Students can collect data on specific topics
- Teachers or students can post examples or non-examples of specific ideas or themes
- Teachers can create a visual FAQ of often misunderstood topics

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5.2.3. Educational benefits of Glogster

- develops written, speaking, and listening skills,
- fosters visual literacy skills,
- uses an engaging, expressive format,
- provides creative and artistic learning opportunities,
- highlights main ideas and supporting details,
- emphasizes relationships between ideas,
- integrates technology with the curriculum,
- Safe and private to use with students

5.2.4. Strategy in Practice

- Glogster can be used in educational settings as an alternative to traditional poster presentations.
- Familiarize yourself with Glogster before introducing it to students.
- Tips for use appear at the bottom of the glog editing screen and educational resources are available on the Glogster EDU homepage.
- Glogster is a social networking site; special permission may be needed to use it in the classroom.
- Register for the education version of Glogster at Glogster EDU. After you receive e-mail confirmation, you can create up to 200 numbered student accounts.
- Preview examples of glogs from Glogpedia, a collection of the best Glogs confirmation available at Glogster EDU.
- Create a step-by-step tutorial for students to teach your students how to create a glog. Provide students with ample opportunities to practice using Glogster.
- Teach students to create a glog using a think-aloud approach; model the importance of selecting appropriate features, organizing the elements with the reader in mind, and developing ideas using multiple modes. Model for students how to use images and graphics to guide the reader.
- Develop a scoring rubric to assess students' glogs; consider technical considerations such as the use of features as well as the quality, relevance, and organization of the elements.
- Provide support and scaffolding for students who may have difficulty finding appropriate images or media files to incorporate into their glogs.

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5. 3. How to connect Collaborative Tools and Interactive Resources(social media, video and image processing, YouTube channels) with the curriculum and with primary and secondary schools

In educational institutions, the development of teaching-learning materials is regarded as one of the major aspects that would promote student learning and help in the achievement of academic goals and objectives.

Teaching-Learning Materials (TLMs) are the tools that are used by teachers and instructors within schools to facilitate learning and understanding of concepts among students.

The primary significance of teaching-learning materials is recognized within the classroom environment by providing support and assistance to the educators with the presentation and transmission of educational content and the achievement of educational objectives.

Teachers, instructional designers, and educational institutions have started to rely heavily on the use of social media in formal learning, to share practices, promote information and educational material, and share opinions, views, and comments, embodying them in training programs and individual courses. One of the best outcomes is that learning has become learner-centric and not teacher-centric, which is the way it should have been all along.

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